GEOLOGICAL SURVEY MEMOIRS
ENGLAND & WALES

WELLS AND SPRINGS OF GLOUCESTERSHIRE

H.M. STATIONERY OFFICE
1930

ARIZONA BUREAU OF MINES

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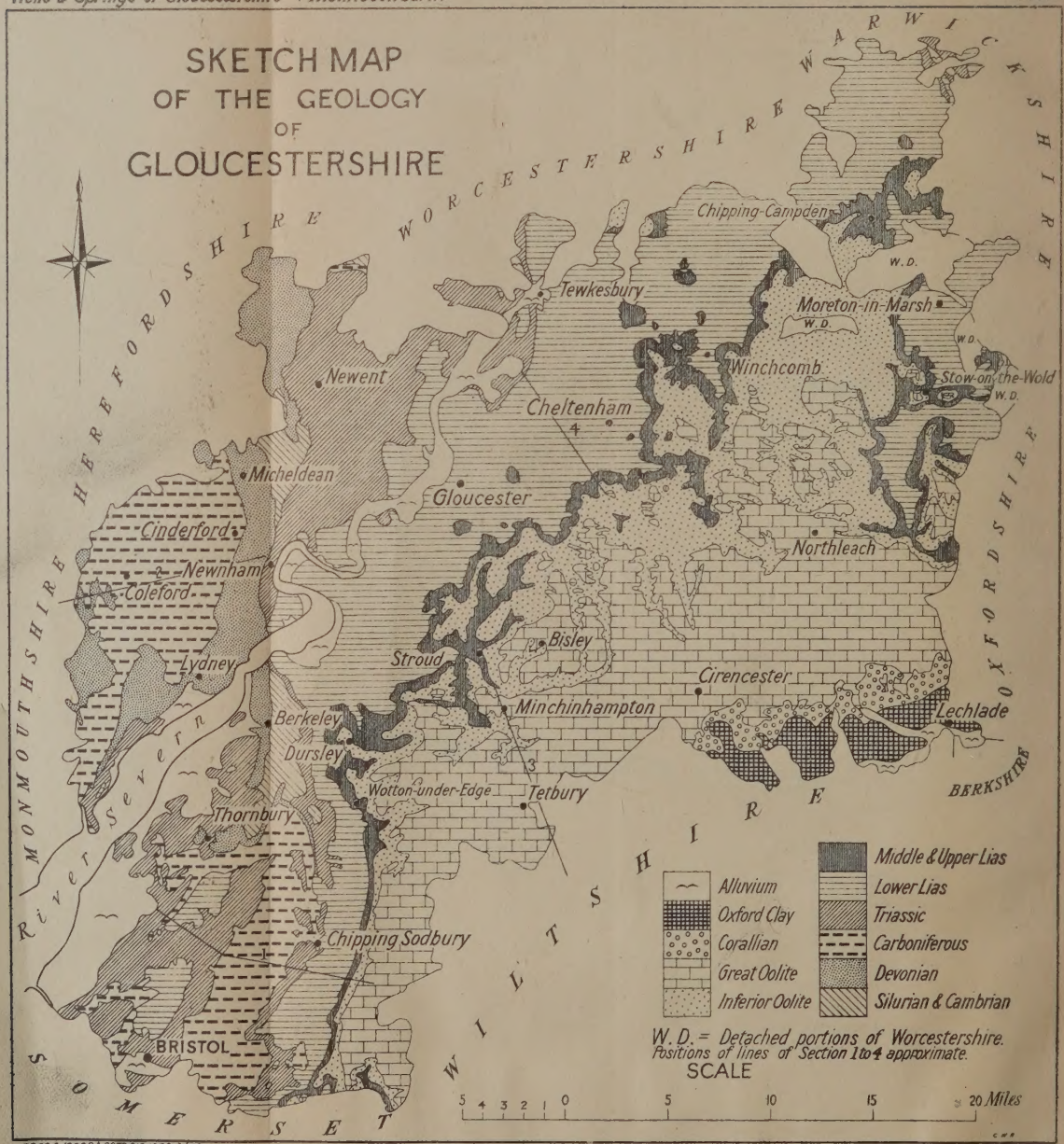

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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

MEMOIRS OF THE GEOLOGICAL SURVEY
ENGLAND

Wells and Springs of Gloucestershire

By

L. Richardson, F.R.S.E., F.G.S.

LONDON
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PREFACE

A glance at the table of Geological Formations on the second and third pages of this volume will show the great variety of rocks that occur in Gloucestershire from which supplies of underground water may be drawn if the circumstances are favourable. The county may be divided into a western portion consisting mainly of Palaeozoic rocks, and an eastern portion where the rocks are mostly Mesozoic. The western area is hilly, the eastern area has much smoother surfaces. The older rocks contain as a rule very little water, but the Carboniferous Limestone and Pennant Grits often yield considerable supplies. In the regions composed of Secondary rocks, however, the connexion between geological structure and water supply is very close. The sandstones of the Trias are full of water, which is sometimes hard and somewhat saline; and the fissured structure of the oolites is eminently favourable for the existence of deep-seated sources. The Lias and the Fullers' Earth hold up the underground water and their outcrops are marked by many springs.

The district is mostly rural, and the principal towns are Cheltenham and Bristol, and special attention has been given to their water supplies by the author of this Memoir.

Mr. Richardson has collected a great amount of information on the subject with which he deals, only part of which could be utilized owing to limitations of space.

The author has had the assistance of many officials of local authorities, engineers and well borers, whose names will be found in the text and are too numerous to specify in detail. He is especially indebted to Mr. E. G. Hampshire who most generously did a large amount of work in obtaining details in the large Northleach Rural District. Mr. Dines has assisted with the editing under the superintendence of Mr. J. Allen Howe.

JOHN S. FLETT,
Director.

Geological Survey Office,
28, Jermyn Street,
London, S.W.1.
4th March, 1930.

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WELLS AND SPRINGS OF GLOUCESTERSHIRE

I.—INTRODUCTION

Gloucestershire ranks thirteenth in size among the counties of England and Wales. In the county there is a great variety of rocks. The geological formations include a mass of Archaean rocks at Chase End Hill; strata ranging from the Silurian to the Oxfordian inclusive; extensive deposits of gravel and sand on the surface of the Oxford Clay of the Upper Thames basin and of the Keuper Marl and the Lower Lias clays of the Severn Valley; and the Alluvium of the Severn.

The formations ranging from the Silurian to the Oxfordian belong to two great geological divisions, the Palaeozoic and Mesozoic. Those belonging to the Palaeozoic division occur at the surface to the west of a somewhat sinuous north and south line running from the neighbourhood of the southern end of the Malvern Hills, *via* Berkeley Road Station to the southern limit of the county near Bitton—a village midway between Bath and Bristol; those belonging to the Mesozoic division, to the east thereof. Minor extensions from the main mass and outlying masses of Mesozoic rocks occur, locally, on the Palaeozoic rocks to the west of the line indicated; but with the exception of one or two places where Carboniferous rocks protrude through the Lower Lias near the eastern margin of the Bristol Coalfield, to the east of that line they are deeply buried beneath the Mesozoic rocks of the vale and of the upland of the Cotteswold Hills. The Palaeozoic rocks are continuous beneath the Mesozoic rocks; Upper Coal Measures, resting on the Silurian, have been proved beneath the Vale of Moreton below Lower Lemington at 1,021 ft. 6 in. and 1,546 ft. down respectively (see p. 113); and Coal Measures at 1,184 ft. down below Burford Signet, a little east of the county-boundary in Oxfordshire (p. 111).

The Palaeozoic rocks were greatly flexed and subjected to lengthy denudation before the Mesozoic rocks were laid down unconformably upon them. In consequence, the Palaeozoic rocks are found inclined in various directions, generally at fairly high angles, while the Mesozoic rocks, although they have been slightly flexed, have a prevalent easterly to south-easterly inclination at relatively low angles.

These differences in the inclinations and in the weather-resisting powers of the Palaeozoic and Mesozoic rocks, together with the presence of an old land surface carved out of the Palaeozoic rocks, which is being more and more exposed as the covering of Mesozoic rocks is stripped off, have determined in the main the land-relief of to-day. Where the Palaeozoic rocks prevail the land-relief is diversified; where the Mesozoic rocks prevail, except in the North Cotteswolds, it is relatively flat or only slightly inclined. The

Forest of Dean exemplifies the former: the Vale of Gloucester and the upland of the Cotteswold Hills the latter.

The two divisions of the county are as distinctive in matters of water-supply as they are in rock-structure and land-relief. This will be gathered from subsequent remarks on the water resources of the various formations and on the methods that have been adopted to supply the various cities, towns, villages and isolated mansions, farms and cottages.

Geological Formations

In the following the geological divisions and sub-divisions of the rocks occurring within the county are stated in descending sequence.

Superficial Deposits

Recent: Alluvium (0 to 20 ft.[1])
Pleistocene: Boulder clay, sand and gravel (0 to 76 ft.[1])

Solid Formations

Jurassic

- Middle Oolites
  - Oxford Clay (not above 193½ ft.)
  - Kellaways Beds (up to 76 ft.[1])
- Lower Oolites:
  - Cornbrash (13 to 16 ft.)
  - Forest Marble
    - Clay (up to 20 ft.)
    - Sands (inconstant) and limestones with clay partings (say 6½ ft.)
    - Clay (? 0 to 8 ft.)
  - Great Oolite (up to 133 ft.)
  - Fullers' Earth Series
    - 'Passage Beds' (? 0 to 6½ ft.)
    - Clay (1 to 135 ft.)
  - Inferior Oolite (20½ to 250 ft.)
- Lias:
  - Cotteswold Sands (0 to about 230 ft.)
  - Upper Lias clay (? 10 to 280 ft.)
  - Middle Lias
    - Marlstone (? 0 to 36 ft.)
    - Sandy Beds (? 0 to 267 ft.)
  - Lower Lias (up to 961 ft.)
    - Blue clays
    - Limestones and clays alternating

Triassic

- Rhaetic: (20 to 48½ ft.)
- Keuper:
  - Marls (0 to 1,523 ft.)
  - Sandstone
- Bunter: Sandstone (proved up to 1,190 ft.)

'Permian' Haffield Conglomerate

Carboniferous

	Bristol District	*Forest of Dean*
Coal Measures	Upper Coal Measures (1,000 ft.)	Upper Coal Measures (1,509 ft.)
	Pennant Grit (2,000 ft.)	—
	Transition Series (2,700 ft.)	—
	Millstone Grit (1,000 ft.)	—
Carboniferous Limestone Series	Upper Limestone Shales (0 to 559 ft.)	—
	Mountain Limestone (910 ft. to 1,501 ft.)	Drybrook Sandstone (0 to 650 ft.) Mountain Limestone (0 to 700 ft.)
	Lower Limestone Shales (380 ft. to 483 ft.)	Lower Limestone Shales (0 to 180 ft.)

[1] Thickness taken from 'Thicknesses of Strata' (*Mem. Geol. Surv.*), 1916.

Old Red Sandstone	
UPPER SERIES	(Mitcheldean district, 500 ft.)
BROWNSTONE SERIES	(,, ,, 2,250 ft.)
RED MARL AND CORNSTONE SERIES	(,, ,, 4,700 ft.)
Silurian	
DOWNTONIAN	Downton Castle Sandstone (0 to 200 ft.)
LUDLOW	(0 to 400 ft.)
WENLOCK	Wenlock Limestone (0 to 500 ft.) ,, Shales (0 to 800 ft.) Woolhope Limestone (0 to 70 ft.)
LLANDOVERY OR MAY HILL SANDSTONE	(up to 600 ft.)
Pre-Cambrian	
? LONGMYNDIAN MALVERNIAN	Huntley Quarry Beds

SILURIAN

Silurian rocks occur at the surface in two areas in the county, namely, the May Hill and Tortworth-Purton areas, and have been encountered immediately below Coal Measures beneath Lower Lemington in the Moreton Valley.

The Silurian of the May Hill area has been mapped and described in detail by C. I. Gardiner[1]. These beds are very much faulted; but, roughly speaking, their arrangement is domical, with an important fault, whereby Keuper beds are brought into juxtaposition with the Silurian, mainly accounting for the imperfection of the dome.

The Silurian beds in this area are not of much interest from a water-supply standpoint. The shaly layers in the Yartleton Beds (Llandovery) retard the penetration of water, give rise to springs and marshy ground, and render water available in dips and somewhat shallow wells. On the other hand water sinks more deeply into the coarser, stratigraphically lower, sandstones of the Huntley Hill Beds (Llandovery). Some of this water flows down from the northern slope of May Hill ultimately into the Ell Brook; some, from the neighbourhood of Glasshouse, also ultimately into the Ell Brook by way of Byfords; and some from Bright's and Huntley Hills into the deep valley which separates these hills, and in which there is a stream that leaves the Silurian for the Keuper tract near Woodend Farm. One of the schemes for supplementing the water supply of Gloucester was to construct impounding reservoirs near Byfords (175 ft. above O.D.) and Woodend Farm (about 210 ft. above O.D.).

The Llandovery Beds are succeeded, in ascending order, by Woolhope Limestone, Wenlock Shales, Wenlock Limestone, and Ludlow Beds, which contain little water; but the depression where the Wenlock shales crop out is usually water-logged and is in part

[1] *Proc. Cotteswold Nat. F. C.*, vol. xx, pt. 3, 1920, pp. 185-222 and pl. [map: 2 in. = 1 mile]. References to previous literature are given in this paper.

drained by the uppermost reach of the Ley Brook. The water-course of this reach contains water only in wet periods: usually the brook rises at the useful "Royal Spring," Little London.

The Silurian and associated igneous rocks of the southern part of the Tortworth-Purton area have been described in detail by Profs. C. Lloyd Morgan and S. H. Reynolds.[1] The rocks are of little interest from a water-supply standpoint and the only spring of note is Wanswell, a mile and a quarter north of Berkeley, in Hamfallow parish, which issues from near the junction of the Ludlow and Old Red Sandstone.

OLD RED SANDSTONE

The Old Red Sandstone occurs at the surface in a tract on which Preston and Dymock are situate; around the Forest of Dean Coalfield; and in places margining the Bristol Coalfield. Throughout these tracts the deeper wells sunk into it usually yield a constant supply of good water.

Between the Forest of Dean and the Silurian rocks of May Hill the whole formation crops out in a belt of country scarcely two miles wide. Between Mitcheldean and Blakeney the differential denudation of the hard and soft constituent beds has resulted in pronounced ridges and deeply excavated valleys that are cut cross-wise locally by Severn-wards flowing brooks. Between Lydney and Tidenham the land-relief is different: the Old Red Sandstone forms a slope, furrowed by brooks, and over-looked, especially west of Woolaston and Alvington, by the towering scarp of Carboniferous Limestone. Along this eastern side of the Forest of Dean and the southerly extension of beds belonging to the Carboniferous Limestone Series water issues copiously, especially from the quartz-conglomerates of the Upper Series. The deep well of the Cinderford Waterworks in Greenbottom derives two-thirds of the water supply of these Waterworks from these uppermost beds, and Lydney and Woolaston obtain their supplies from approximately the same geological horizon. On the western side of the Forest and the southerly extension of beds belonging to the Carboniferous Limestone Series springs are not so copious; but the St. Briavels supply, and the only reliable but private supply at Hewelsfield are derived from springs, caught in wells, that issue from the uppermost beds of the Old Red.

The Old Red Sandstone rises up from beneath the Carboniferous rocks of the Bristol Coalfield, but its outcrop is not continuous: in many places the beds are hidden beneath younger rocks and are frequently displaced by faulting. Its thickness is not known, but it may be assumed that it is not less than in the Mitcheldean district. Neither has its water resources been ascertained: it is unlikely that they will be tested for public purposes as piped-supplies are obtained from other sources.

[1] *Quart. Journ. Geol. Soc.*, vol. lvii, 1901, pp. 267-284; *ibid.*, vol. lxiv, 1908, pp. 512-543.

CARBONIFEROUS

Rocks belonging to this system occur at the surface in and associated with three coalfields in the county, namely, the Newent, Forest of Dean and Bristol Coalfields.

Newent Coalfield.—Here Coal Measures, equivalent to either the Upper or Transition Coal Measures of Radstock and Bristol, crop out along a narrow tract, resting unconformably on the Old Red Sandstone on the west and dipping down beneath the New Red Sandstone (Trias) to the east. Their chief interest from the present standpoint is that they hold up an abundance of water in the Triassic Sandstone.

Forest of Dean Coalfield.—This basin of Carboniferous rocks (Fig. 1) is situate between the Severn and the Wye. It has a maximum length of 12 miles, measured from Howle Hill on the north to Aylburton on the south, and a maximum breadth of 8 miles east and west. In the centre of the basin are the Coal Measures, occupying an area of about 16,700 acres; from beneath which rise up in succession, Drybrook Sandstone (long known as the 'Millstone Grits,' but shown by Dr. T. Franklin Sibly to be a sandy phase of the uppermost beds of the Carboniferous Limestone Series), Carboniferous Limestone and Lower Limestone Shales, except for a short distance in the south-east where the higher Coal Measures overstep the lower beds and rest unconformably on the Old Red Sandstone. A tongue of Carboniferous rocks—outliers of Drybrook Sandstone resting on Carboniferous Limestone and the latter on Lower Limestone Shales, stretches southwards to the Wye.

The sequence of the constituent beds of the Coal Measures has been worked out by E. A. Newell Arber,[1] and of the Carboniferous Series by Dr. Sibly.[2]

Carboniferous Limestone :—		Wigpool Syncline	Lydney Park Syncline
		Thicknesses in ft.	
Main Limestone	Whitehead Limestone ...	40 to 60	about 200
	Crease Limestone ...	75 to 100	
	Lower Dolomite... ...	250 to some 400	
	Lower Limestone Shales	about 180	

The surface-drainage of the Forest is mainly to the south-east, into the Severn, by means of the Soudley, Blackpool and Cannop Brooks; but as might be expected from the basin-like arrangement of the beds and the lithic characters of certain of them, a great quantity of water finds its way underground to the discomfiture of those engaged in mining pursuits. W. D. Meredith, Manager, Henry Crawshay and Co., Ltd., has supplied the following particulars as to the quantities of water pumped out of the chief pits.

[1] Arber, E. A. Newell, *Phil. Trans. Roy. Soc.*, ser. B., vol. ccii, pp. 235, 236, 268. See also *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 3, for 1923 (1924), pp. 196-198.

[2] 'Special Reports on the Mineral Resources of Great Britain' (*Mem. Geol. Surv.*), vol. x (Iron Ores (contd.), The Haematites of the Forest of Dean and South Wales), 1919, pp. 6, 7.

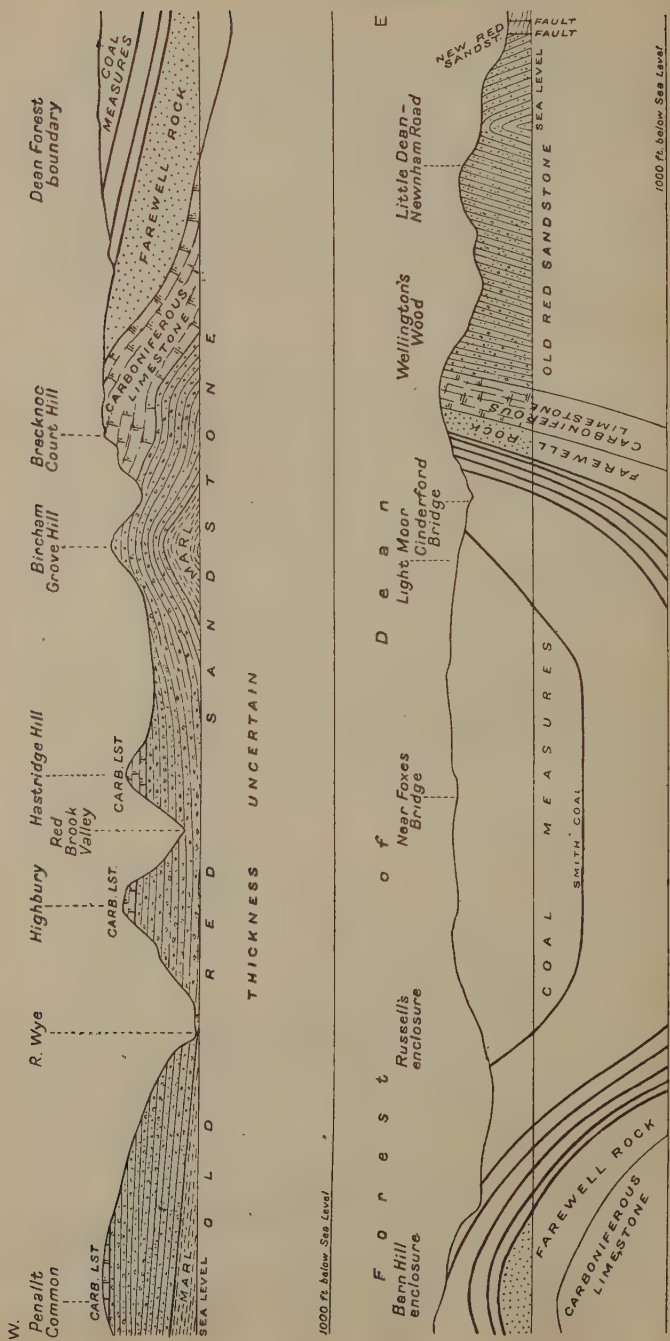

FIG. 1.—*Section No. 2 across the Forest of Dean Coalfield.*

He says "It must be thoroughly understood that these quantities are approximate, and what I consider an average over twelve months.

"In addition to these quantities there are several adits or levels driven into the sides of the hill all round the coalfield which are called 'free drainage levels'—in wet times the quantities of water from these sources are enormous, but we have no means of estimating the amounts.

"There are also several small pits pumping, of which it is practically impossible to get any record."

Name of Colliery	Gallons pumped up per minute (approximate)
Princess Royal	2,000
Cannop	2,000
Lightmoor	300
Foxes Bridge	250
Crumpmeadow	250
Trafalgar	100
Norchard	1,300
Parkend	450

These mining operations, both for coal and iron, have caused the lowering of the water-level and the draining of many wells, those in the Greystone rock being particularly affected. For this reason many places in the Forest have long been badly off for water. Many in West Dean still are and have to depend on 'reservoirs'—rainwater storage tanks (see p. 167); but the problem has been solved for the Township of East Dean by the Cinderford Waterworks.

A large quantity of water accumulates in the fissures in the Carboniferous Limestone, in which it is held up by the subjacent Lower Limestone Shales. Wm. Whitehouse informs me that water drains out of the Limestone at Silly Point, Shakemantle, into Blackpool Brook, a Severn stream; and at Upper Lydbrook into 'The Lydd,'[1] a Wye stream. The spring at Clearwell, thrown out by the Lower Limestone Shales, drains a tract of Carboniferous Limestone; and that at the foot of Ban-y-Gor Cliff (the source of supply of the Tidenham section of the Chepstow Water Company), part of a tract of synclinally arranged Carboniferous rocks which is cut through by the deep valley of the Wye.

Bristol Coalfield.—The Bristol Coalfield is situated between Tortworth and the River (Bristol) Avon. The Coal Measures occupy the centre of the basin, but neither they, nor the successive outcrops of the subjacent Carboniferous Limestone and Lower Limestone Shales are completely exposed, owing to superincumbent Mesozoic rocks locally obscuring them (Fig. 2).

The Pennant Grit is at most localities full of water: the Frampton Cotterell iron mine, the original and still the chief source of supply of the West Gloucestershire Water Company, was abandoned because the pumps of the time were inadequate to cope

[1] The same name is also occasionally applied to the Cannop Brook.

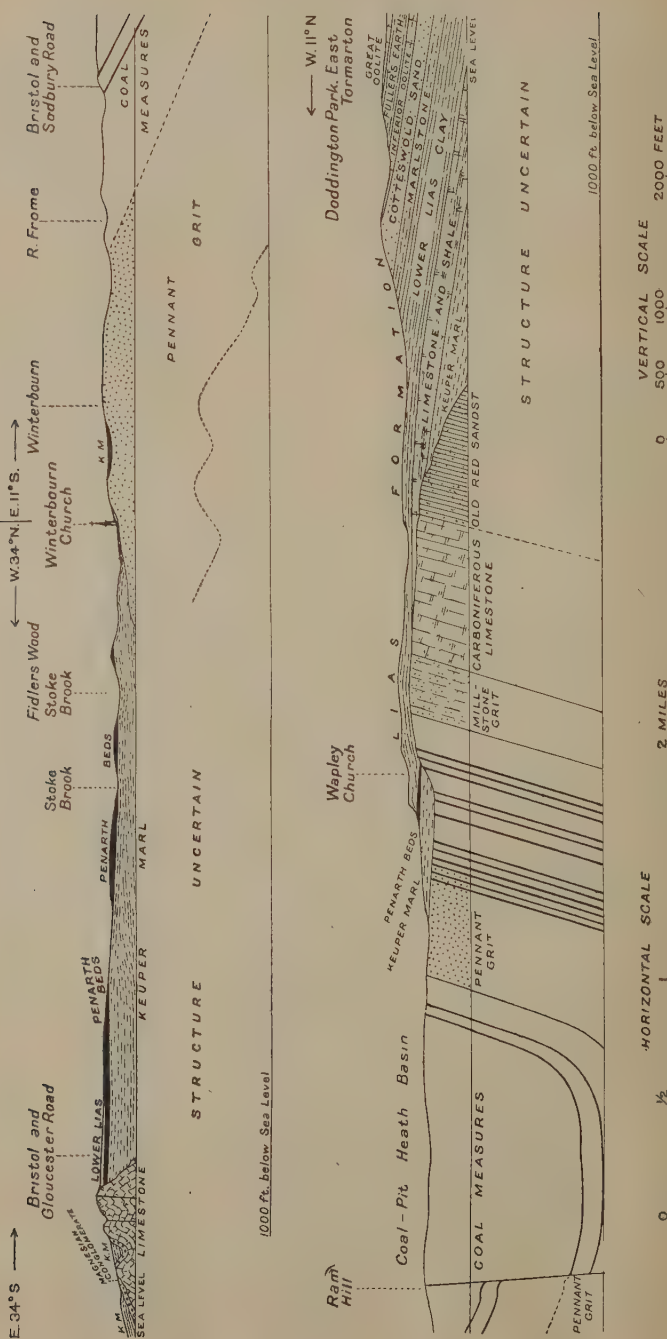

FIG. 2.—*Section No. 1 across Bristol Coalfield.*

with the inflow of water. Wells, sufficiently deep, in the Pennant Grit usually yield an abundant supply of water ; but pumping soon lowers the levels of the waters in the wells in the vicinity. The pumping, which had to be undertaken for a time by the West Gloucestershire Water Company at the Dog Trap Pit, Yate, and its effect on the wells within a radius of about a mile is a good example. The villages and isolated houses on the Coal Measures dependent on wells are, however, on the whole poorly off for water, in part owing to mining operations and, as in the Forest of Dean, a network of mains has had to be developed from a large undertaking in the Bristol Coalfield area outside Bristol City, the West Gloucestershire Water Company. The further extension of the mains is the best solution to the difficulty. Boring for water at the Douglas Motor Works, Kingswood, gave negative results.

Water from the Carboniferous Limestone of the northern extremity of the Coalfield is drained off into the Little Avon River by the stream that in its lower reaches is called the Tortworth Brook, and of the Henbury district into the Bristol Avon by the Trym and its tributaries.

Trias

The Trias in Gloucestershire comprises :—

			Thicknesses in ft.
Rhaetic			20 to 48½
Keuper	Marl	Tea-green Marls	0 to 25
		Red and variegated marl	0 to 190
		Arden Sandstone ...	0 to 25
		Red marl	0 to 1,283
	Sandstone	Sandstones, shales and marl	Proved up to 1,190 ft. in Oxenhall parish
Upper Bunter		Sandstone...	

The Bunter and Keuper Sandstones occur at the surface in a tract, roughly 7 miles by 2 miles, that is situate between the southern end of the Malvern Hills and May Hill. The greater part of the eastern boundary is a fault : the northern part of the western boundary is also a fault ; but to the south, the Sandstones rest at some places on Upper Coal Measures and at others on Old Red Sandstone. The Sandstones are probably affected by several faults and must dip steeply eastwards, for, scarcely two-thirds of a mile to the east of their western limit, close to the " Newent " Pumping Station of the Gloucester Corporation Water Works in Oxenhall parish, a boring proved 1,190 ft. of them without reaching their base.

The Sandstones in this tract are very permeable and readily absorb water, which is held up in them by the subjacent clays and shales of the Coal Measures. The tract in which they occur, certainly the more northern portion, is more elevated than that to

the east, which is floored by the Keuper Marl. It is traversed by the River Leadon and Ell Brook—by the Leadon in a deep picturesque valley. Leading from the main valleys are numerous tributary valleys, which become more and more shallow the further they are followed upwards, until they die away in mere undulations in the higher ground. These tributary valleys are for the most part, and, as a rule, wholly, dry: such perennial springs as there are break out in their lower reaches, generally quite close to the main streams. These valleys and depressions tend to lower the level of the water-table. Wells sunk in the higher ground often have to go down considerable depths to ensure a supply all the year round. For example, one at Poolhill, Pauntley, is 100 ft. deep, and in July, 1922, had 50 ft. of water in it. This depth of water suggests that the level of the water-table fluctuates considerably.

The abundance of water in the Sandstones and the readiness with which the store is replenished are facts which have been appreciated; the Malvern Urban District has three bore-holes (all 200 ft. deep) at Bromsberrow Heath and the Gloucester Corporation two boreholes at Ketford (respectively 359 ft. and 447½ ft.), and a well (168 ft.) at the 'Newent' Pumping Station in Oxenhall parish.

Keuper Sandstone crops out from beneath the Keuper Marl along a narrow tract terminating at Huntley and faulted against the Silurian rocks of May Hill. South of Huntley the Sandstone disappears beneath the Marl, but was encountered at a depth of 600 ft. near Stanley Farm in Blaisdon parish. The water obtained, however, was too hard for domestic purposes.

The water from the upper portion of the Sandstones in the main tract is excellent in quality, but hard: the deeper-seated water is very 'salty' and the salinity increases with the depth. Some of these deeper seated waters find their way to the surface near the eastern boundary fault in the neighbourhood of Hilltop, near Newent, and of Durbridge, near Pauntley. At the latter locality some are highly impregnated with sulphuretted hydrogen.

It is not possible to indicate the geographical extent of the Upper Bunter Sandstone beneath the newer rocks of the County; but that of the Keuper Sandstone is considerable: it was proved beneath Lower Lemington in the Vale of Moreton between 947½ and 1,021½ ft. down and rests on Coal Measures.

The Keuper Marl in South Gloucestershire is relatively thin, but it must be very thick in the neighbourhood of Tewkesbury, for a borehole at Red Hill, Upton-on-Severn (Worcs.) penetrated 1,327 ft. before reaching the Keuper Sandstone. It dips to the east, and is present below the Lower Lias of the Severn Valley to the east of the river. It was proved between 466½ and 947½ ft. down below the Vale of Moreton, where it rests on Keuper Sandstone.

The villages and scattered houses on the Keuper Marl appear to be, generally speaking, adequately supplied with water from

dug wells, some of which are deep. I have not heard of any of the waters being saline. No public piped supply is obtained from the Keuper Marl in this county and there is a tendency for villages and isolated houses on the line of, or within reasonable distances of, the mains of the Gloucester and Cheltenham Corporations' Waterworks to be connected thereto.

LOWER LIAS

The Lower Lias occurs at the surface along a comparatively narrow tract stretching from the River Avon, near Bitton, to Berkeley Road Station, and situate between the foot of the Cotteswold Hills and the Palaeozoic Rocks of the Bristol Coalfield. In advance of this tract are several outliers, of which the largest are those on which (1) Horfield and Filton, and (2) Alveston, are built.

To the north of Berkeley Road Station the surface-extent of the Lower Lias widens out, and, with the exception of a comparatively small area where Keuper Marl occurs in the neighbourhood of The Leigh, Apperley and Deerhurst (between Gloucester and Tewkesbury), and tracts where it has deposits of sand and gravel (Superficial Deposits) and Alluvium resting on its surface, floors the whole of the vale to the east of the Severn. In advance of the main mass, on the west side of the Severn, are several detached tracts and outliers; but otherwise the vale to the west of the river is floored with Keuper Marl.

On the eastern side of the North Cotteswolds the Lower Lias floors the Vale of Moreton, but here it is locally deeply buried beneath deposits of gravel and sand (Superficial Deposits). Lower Lias also floors the initial portions of the valleys that incise the Cotteswood upland, such as the Dursley, Stroud and Chelt valleys, the valley at Winchcomb, and the almost completely enclosed vale of Bourton.

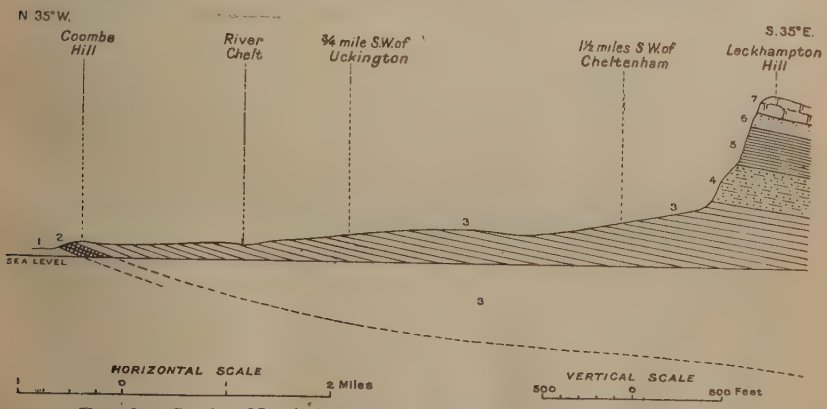

FIG. 3.—*Section No. 4, between Coombe Hill and Leckhampton Hill.*

1. Keuper Marl. 2. Rhaetic. 3. Lower Lias. 4. Middle Lias. 5. Upper Lias. 6. Cotteswold Sand. 7. Inferior Oolite.

The Lower Lias doubtless underlies the newer rocks of the whole of the Cotteswold Hills, but it has not been reached by deep borings in Gloucestershire although it has been proved below Burford Signet in Oxfordshire.

From a lithic standpoint the Lower Lias is divisible into two parts :—

(1) An upper, consisting in the highest portion of somewhat sandy clays with occasional beds of impure limestone, passing down into the blue clays which constitute the main mass, and

(2) a lower, consisting of usually regularly-bedded argillaceous limestones with alternating deposits of shale and clay of various thicknesses.

The thickness of the Lower Lias is not known at every locality in the county at which it occurs.

A study of the fossils of the Lower Lias clays and limestones exposed in clay-pits, railway cuttings, or in the sinking of wells, has demonstrated that the beds do not dip regularly in directions between east and south-east, but have been affected by flexing and faulting which, however, is not so apparent as in a series of more diverse stratal composition such as the Oolites.

The Lower Lias is not a formation in which water in any large quantity may be expected. Wells sunk into the lower portion, which contains the numerous limestone beds, may yield a sufficient quantity, in fact often do, to supply a cottage or two ; but it is usually hard, as is apparent from the calcareous tufa that has been deposited by the water seeping out of the beds at Sedbury and Wainlode Cliffs, and sometimes, as at Cherryrock Farm, near Kingswood, mineralized. Locally a few small springs issue from the beds. Indeed, what Tiddeman wrote concerning the lower portion of the Lower Lias as it occurs in Oxfordshire is true of the equivalent beds in this county also.[1]

In the clays of the upper portion of the Lower Lias little water is to be met with. Wells sunk into the deposits almost anywhere in the vale north of Berkeley Road Station are likely to yield a saline water and occasionally the water gives off sulphuretted hydrogen. The wells in this portion of the Lower Lias occasionally penetrate a line of limestone nodules along which some of the little water collected makes its way, but as often as not the bulk of the water in the well is surface-water that has percolated through the subsoil and has run into the well from where subsoil and Lias clay meet. As the Lias gives rise to a tenacious clay soil which cracks badly in dry weather, impurities may often in this way obtain access to the wells.[2] Successful wells in this portion of the Lower Lias will often be found to have cut fissures or pockets filled in with gravel.

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[1] 'The Water Supply of Oxfordshire' (*Mem. Geol. Surv.*), 1910, p. 5.

[2] This cracking of the Lower Lias clay often causes much damage to the foundations of houses built upon it and the ingenious suggestion has been put forward that this is the reason why so many of the large houses in the vale in the days gone by were moated.

Numerous rivers and streams belonging to the Severn System flow over the Lower Lias, but none of importance originates from it. A few springs issue from the neighbourhood of the limestone beds in the lower portion of the Lower Lias in the tract south of Berkeley Road Station ; but such streams as do have their genesis in the vale to the north arise from the deposits of sand and gravel which occur locally on its surface or from the confluence of surface-drainage.

In nearly every case, if a town or village is situate well away from the hill-slopes on the Lower Lias of the vale, the selection of its original site is found to be doubtless due to the occurrence of a sand or gravel deposit. The deposit provided a dry site with water readily accessible by means of shallow wells.

MIDDLE LIAS

The Middle Lias consists of :—

Marlstone. Impure sandy limestone, brown when weathered, but bluish- or greenish-grey hearted ; resting on

Sandy Beds. Sandy clays with locally one or two thin beds of impure sandy limestone and occasional ferruginous nodules.

These beds are apparently absent from the extreme southern portion of the South Cotteswolds, where the basal Upper Lias beds would appear to rest directly on the Capricornus Beds of the Lower Lias. As the escarpment is followed to the north, however, Middle Lias beds come in, and in the construction of the approach-cutting to the western end of the Sodbury Tunnel, typical Marlstone was found resting on beds a few feet thick which have been referred to the Margaritatus Beds. The Middle Lias thickens to the north : at The Quarry, Cam, the Marlstone is more than 15 ft. thick and the Middle Lias beds below are thicker, but by precisely how much has not been ascertained.

The Middle Lias beds thence onwards crop out in the hill-slopes as far as the northern extremity of the Cotteswolds, Meon Hill, and their altitude above O.D. rises, the surface of the Marlstone at Meon Hill, which it caps, being 637 ft. above O.D. The Middle Lias beds below the Marlstone, which in this memoir are referred to as the 'Sandy Beds,' merit their name in the western face of the North Cotteswolds, where they are well developed, and their outcrop clearly indicated by the growth of gorse-bushes and often marshy ground at their foot. The Middle Lias also crops out in the hill-slopes that overlook the Vales of Moreton and Bourton ; but locally its outcrop is obscured by slipped Upper Lias clay.

Springs, the majority insignificant in comparison with those thrown out by the Fullers' Earth and Upper Lias clay, issue from at or near the junction of the Sandy Beds and Lower Lias, but few in this county from the Marlstone. South of Dursley, as the beds below the Marlstone are thin, the most satisfactory wells are those that enter the Capricornus Beds : the deeper wells at The Quarry

certainly do so. The springs issuing from at or near the junction of the Sandy Beds with the Lower Lias increase in volume to the north. Oxenton, ? Beckford, Little and Great Washbourne, Dumbleton (part), Aston Subedge, Mickleton and Broadwell have their piped supplies from springs issuing from this horizon, and so does Shipston-on-Stour—from a strong spring at Ebrington. Hawkins was of opinion that 'Ashwell' spring, Longborough, had its origin in the Middle Lias.

Waters coming from the neighbourhood of the Marlstone, which is somewhat ferruginous, are usually chalybeate, a fact which can be readily observed from the reddish-brown deposit they make. Such springs are: the spring which supplies King's Hill, near Dursley; the Red Well, Matson; the Red Well, Prinknash; a spring at Woodmancote (which now forms part of the supply for Bishop's Cleeve); Red Water Spring and Chair Spring, Dumbleton; Showell's Lane Spring, Batsford; and that at Spa Cottages, Lower Swell.

INFERIOR OOLITE, COTTESWOLD SANDS AND UPPER LIAS CLAY

Table of Thicknesses of Upper Lias Clay, Cotteswold Sands and Inferior Oolite in Gloucestershire.

Locality	Thicknesses in feet			Authority
	Upper Lias Clay, etc.	Cotteswold Sands	Inferior Oolite and Cephalopod Bed	
South Wales Direct Line (G.W.R.)	17	185	79	Prof. S. H. Reynolds and Dr. A. Vaughan, *Q.J.G.S.*, vol. lviii, 1902, fig. 2, p. 730
'Leighterton Aerodrome,' Lasborough			101	Henry Marten, p. 169
W. Glos. Water Works, Shipton Moyne		+68	75	L. Richardson
Tetbury U.D.C.'s Waterworks		+59	139	,,
G.W.R. Station, Kemble		+54½	117½	,,
Chedworth District ...		+27⅚	139⅔	H. B. Woodward, 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv (1894), p. 127.
Bourton-on-the-Hill (west of)			200	L.R.
Little Rissington ...	100	absent	about 25	,,
Burford Signet, Oxon	82⅙	absent	? 27	H. B. Woodward, 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv (1894), p. 303.

These three formations are considered together because, with the exception of a comparatively thin, but locally important from the present standpoint, bed of clay (Snowshill Clay), the first two are permeable,[1] the last impermeable. At or near the top of the Upper Lias clay is the most important horizon from a water-supply standpoint in the Jurassic rocks of Gloucestershire.

The Inferior Oolite has a comparatively narrow outcrop area in the South Cotteswolds; but is exposed in the sides of numerous, many-branched valleys which incise the upland in the neighbourhoods of Wotton-under-Edge, Dursley and Nailsworth, and caps prominent spurs, such as Stinchcombe, Selsley and Rodborough Hills. It is displayed in the sides of the Frome Valley above Stroud, caps many of the ridges and prominences in the neighbourhood of Painswick; but between Birdlip and the Vale of Moreton occurs at the surface over a wide tract of country and crops out in the sides of many valleys that extend into the region where the Fullers' Earth and Great Oolite predominate.

The Cotteswold Sands attenuate, as sand, from the neighbourhood of Bath northwards and north-eastwards and fail altogether in the neighbourhood of the Rissingtons on the east side of the Vale of Bourton, where the top beds of the Inferior Oolite rest directly on Upper Lias clay. On the other hand, the Upper Lias clay thickens from south to north; but thins to the east in the hills that overlook the Vale of Moreton.

On p. 14 are given the thicknesses of the three formations of limestone (Inferior Oolite), sand (Cotteswold Sands), and clay (Upper Lias) at certain places in the Cotteswold Hills. These formations have not a uniform dip in one direction. A synclinal axis runs from north-west to south-east through Pitchcomb, near Painswick; an anticlinal axis roughly follows the line of the Ermine Street from Birdlip to Cirencester; a synclinal axis runs from Cleeve Hill, *via* Chedworth, in the direction of Ampney Crucis; and an anticlinal axis is indicated by the Vale of Moreton. A minor anticlinal roll may be indicated by the Charlton Abbots valley.[2] This flexing of the Inferior Oolite and the subjacent Cotteswold Sands and Upper Lias clay has had an important influence on the development and direction of river-basins in the Cotteswolds and on the flow of underground waters.

Numerous faults displace the Inferior Oolite, especially in the Mid and North Cotteswolds. These have caused the outburst of springs where copious supplies would not otherwise have been available.

The deep valleys which furrow the more extensive tracts where the Inferior Oolite occurs at the surface and are sunken locally

[1] Explanation is necessary of the meaning of the term permeable especially in connection with the Inferior and Great Oolites. The limestones absorb water but such absorbed water is not readily parted with; the water that is available for supplies is contained and circulates in *fissures*.

[2] See S. S. Buckman, *Quart. Journ. Geol. Soc.*, vol. lvii, 1901, p. vi.

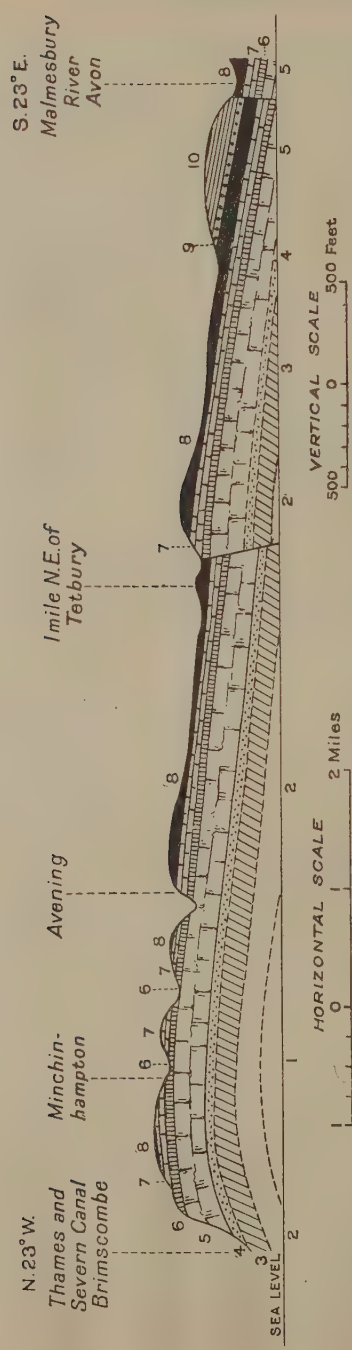

FIG. 4.—*Section No. 3, between Brimscombe and the River Avon.*

1. Lower Lias. 2. Middle Lias. 3. Upper Lias. 4. Cotteswold Sand. 5. Inferior Oolite. 6. Fullers' Earth. 7. Great Oolite. 8. Forest Marble. 9. Cornbrash. 10. Oxford Clay.

into the Cotteswold Sands and even into the Upper Lias clay tend to lower the water-table in the contiguous rock-masses and cause dry hills, with water far below the surface, which are given over to cereals, roots and pasture. The portions of the valleys that are cut down to the clay contain swiftly-flowing streams of the clearest water which soon overflow their banks in periods of heavy rain; but those that are sunken only into the Sands are usually dry except when and where the water-table rises above the levels of the valley-bottoms. Faults cross many of the valleys affecting the normal relationships of the beds, and where such is the case the phenomenon may be witnessed of a stream flowing in some parts and not in others.

Springs thrown out by the Upper Lias clay are very numerous and many are very copious. Between Upton Cheney and Hillsley, in the South Cotteswolds, the rocks dip into the hills, the outcrops of the Sands and Inferior Oolite are narrow and consequently little water issues from the hill-sides. Villages along this section of the hills as a result are few and small. Some water is tapped east of the escarpment by the St. Catherine's and Oakford Valleys below Marshfield, and many of the springs are collected and conveyed into the Oakwood and Monkswood reservoirs for the part supply of Bath. In the neighbourhood of Wotton-under-Edge and Dursley deep sinuous valleys dissect the hills, and as they incise the dip-slope of the Upper Lias clay numerous springs break out in them. There are fine springs at Kilcott, Ozleworth, above Coombe, up Waterley Bottom, and up the Uley Valley, wherein rises the Cam.

Between Dursley and Dudbridge few springs issue: some of the more reliable are used for the supply of Coaley and King's Stanley (part). In the Nailsworth, Horsley and Avening Valleys, which run far into the upland in places intersecting the dip-slope, copious springs break out, such as at Gig Mill, Millbottom, the Coldwell Spring, those at the Midland Fishery in the Horsley Valley, in the grounds of 'Pensile,' and in the vicinity of Longfords Mills up the Avening Valley.

Up the Frome Valley, above Stroud, is the powerful Clerk's Flour Mill Spring (the main supply of the Stroud Water Company), the springs at Bliss Mills, the 'Black Gutter,' etc., and the considerable store of water in the Cotteswold Sands which furnished the original supply (by means of wells) of the Stroud Water Company. The reason for the presence and outflow of so much water here is in the main explained by the contour of the Upper Lias clay (see section, Fig. 4). 'Many Wells,' Cranham, are useful springs: less constant springs in the bay-like expanse in the escarpment feed the Witcombe reservoirs of the Gloucester Corporation. The springs between Birdlip and Nottingham Hill are numerous, but the majority feeble and inconstant. The head-streams of the Chelt are impounded in the Dowdeswell Reservoir; but their yield—on account of the limited catchment-area—is such that the main supply for Cheltenham has

to be derived from the Severn. The Puckham, Syreford, Charlton Abbots, and Corndean springs, and those originating the Postlip Brook, are the result of the drainage of the hill-mass of which Cleeve Hill, the highest point of the Cotteswolds (1,070 ft. above O.D.), is part.

In the North Cotteswolds many copious springs are thrown out by the Upper Lias clay. With the notable exceptions of those in Lidcombe Wood (some of which constitute the source of the Pebworth and Evesham Villages Supply) and Bourton Woods (some of which supply Blockley, Worcs.), nearly all the important springs discharge their waters into valleys in the hill country. This is due to the synclinal arrangement of the rocks. Many valleys, commencing as mere depressions in the upland, drain off the water eventually into the main stream, the Windrush. Notable springs are at Bradwell's Head or Slade Barn, Broadwater, Guiting Power, Kineton, 'The Roaring Wells' of Eyford, at Lower Swell, and those that issue in the neighbourhood of Waterhead Barn, Donnington, and are the product of drainage, partly underground, along the line of a valley which commences far up near Spring Hill in the Worcestershire parish of Broadway. The water is intercepted underground at Waterhead Barn for two supplies; after it has appeared it is impounded in a mill-pond; and farther down spring water is pumped at Upper Swell Mill for the supply of Moreton in Marsh. Then there are the Seven Springs above Bourton-on-the-Water, the Haycroft and other springs near Sherborne, and Windrush Mill Spring; while Great and Little Rissingtons are dependent for their supplies on springs thrown out by the Upper Lias clay in the hills that bound the Vale of Bourton on the east.

Water held up in the Inferior Oolite and Cotteswold Sands by the Upper Lias clay is tapped by the boreholes of the West Gloucestershire Water Company at Shipton Moyne (which, however, have never been used); at the Tetbury Urban District Council's Water Works, at the G.W.R. Station, Kemble (reserve); at Chavenage; Ewepens, Cirencester Park; Leygore Manor, Turkdean; and by the well at the Stow-on-the-Wold Urban District Council's Water Works. Although water is abstracted from the majority of the springs referred to above for the purpose of supplies to towns, villages, mansions, farms and cottages, the bulk of it runs to waste. There are few, if any, places where the yield of springs is sufficiently constant or the geologic structure of the ground such as would permit of the satisfactory construction of impounding reservoirs: water would have to be piped from the springs for considerable distances. Sites for reservoirs have been suggested below Crickley Hill and in the valleys of the Dikler and Sherborne Brook.

As in the case of supplies from the higher water-level in the Cotteswold Hills, namely, the springs thrown out by the Fullers' Earth, the practice is growing of going, where possible, to springs thrown out by the Upper Lias clay, and pumping the water—in

most places by rams—to supply places at higher elevations or allowing it to gravitate to places at lower, in preference to sinking deep wells or boreholes. Like the Great Oolite, the Inferior Oolite is rent with fissures; but there is not the same danger of polluting the springs by depositing filth in the fissures, because, in the more populous parts where the practice is still in vogue to some extent, there are the Cotteswold Sands below, which function as a natural filter.

Waters from the Inferior Oolite and Cotteswold Sands readily part with their contained carbonate of lime, as the tufaceous deposits they make, such as the well-known one at Dursley, demonstrate. They are, however, of the purest nature when delivered; but, as Dr. J. H. Garrett has remarked, when "left for some time exposed to the air and light in reservoirs or receptacles, become the habitat of organic growths, which in the course of time prove themselves capable of altering the chemical composition of the waters, sometimes resulting in such considerable pollution as to render water, which was in the first instance a spring water of excellent potable quality, quite unfit for drinking."[1] Hence the importance of piping the spring water direct into a covered receptacle feeding the main.

Hard waters are particularly prone to encourage the growth of *Chara*. This weed has given much trouble in the open reservoirs at Hewlett (Cheltenham Corporation) and Witcombe (Gloucester Corporation). In the case of the Hewlett Reservoirs and one at Witcombe, cementing of the bottoms stopped their growth for a time. Dr. Garrett says: "A chemical effect of the growth of *Chara* and its accompaniments in our [i.e., Cheltenham] reservoirs is to add considerably to the organic content dissolved in the water, and to reduce the small quantity of nitrate naturally contained in the water to nitrite."[2] *Chara* has also been calculated to reduce the hardness of water by as much as 2° owing to the removal of carbonate of lime.[3]

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[1] *Trans. Inst. Water Eng.*, vol. xvii, 1912, pp. 172-173.
[2] *Ibid.*, p. 174.
[3] *Ibid.*, p. 182.

GREAT OOLITE AND FULLERS' EARTH

Table of Thicknesses of Fullers' Earth and Great Oolite in Gloucestershire.

Locality	Fullers' Earth. Clay	Fullers' Earth. Passage Beds	Great Oolite	Authority
South Wales Direct Line (G.W.R.), Badminton	90	45	100+	Prof. S. H. Reynolds and Dr. A. Vaughan *Q.J.G.S.*, vol. lviii, 1902, p. 741
Hawkesbury Upton ...	90			L. Richardson
'Leighterton Aerodrome,' Lasborough	70		133	Henry Marten
W. Glos. Water Works, Shipton Moyne	85½	61½	79	L. Richardson
Tetbury U.D.C.'s Water Works	79½	47½	103¾	,,
Chavenage, Horsley parish	88	56	63	,,
G.W.R. Station, Kemble	73	48	60+	,,
Stroud Hill	55	15	21+	E. Witchell, *Geol. Stroud*, 1882, Section facing p. 5
U.D.C.'s Water Works, Cirencester		+7	121 5/12	L.R.
The Castle, Hatherop ...	+44 5/12	55 7/12		H. B. Woodward, 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 510.
Chedworth district ...	about 50	132⅓		H.B.W., *ibid.*, p. 245; L.R., *Proc. Geol. Assoc.*, vol. xxii, 1911, p. 114
Great Rissington ...	a few ft.	? absent		L.R., *Q.J.G.S.*, vol. lxiii, 1907, p. 441
Burford Signet, Oxon ...	[absent]	[?absent]	62½	H.B.W., 'Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. iv, 1894, p. 303.

The Great Oolite occurs at the surface over considerable areas in the Cotteswold Hills; but the areas where the subjacent Fullers' Earth occurs at the surface are comparatively narrow and usually margin the Great Oolite.

In general terms it may be stated that the Great Oolite is composed of limestone-beds, but in the Mid and North Cotteswolds eastward of the River Coln a marly clay, etc., is prominent, occupying approximately a median position in the Series. This marly clay, etc., has received the name 'Marly Beds,' and is well

displayed (28¼ ft.) in the railway-cutting at Hampen northward of Salperton near Notgrove, where it at times throws out a spring. The importance of the Marly Beds from a water-supply standpoint has been only recently appreciated: the deposit throws out a number of springs in the district in which it occurs. This Great Oolite rests on the Fullers' Earth Series, which, as a formation composed mainly of clay, attenuates from about 135 ft. in the neighbourhood of Badminton to but a few feet in the neighbourhood of Great Rissington. The upper portion of the Fullers' Earth in the South Cotteswolds, however, as has been proved by the borings at Shipton Moyne, Tetbury and Kemble, and in the Sodbury Tunnel on the South Wales Direct Line, comprises beds of shale, clay, and marly, sandy and argillaceous limestones. Professor S. H. Reynolds and Dr. A. Vaughan designated these beds 'Passage Beds.' As R. Tiddeman once observed this upper part of the Fullers' Earth is only partly retentive and in places carries springs. Some of the springs noticed in the following pages no doubt issue from these beds and their persistence in dry weather may be accounted for by the slower release of the waters by these deposits.

If it had not been for the presence of the Fullers' Earth the greater part of the Cotteswold upland would have been void of villages, isolated farms and cottages. Marshfield, Cold Ashton, West Littleton, Tormarton, Hawkesbury Upton, Lasborough, Newington Bagpath, Kingscote, Nympsfield, Avening, Minchinhampton, Sapperton, Edgeworth, Chalford, Bisley, Miserden, Brimpsfield, Elkstone, Syde, Winstone, Duntisbourne Abbots, Chedworth, Coln St. Dennis, Coln Rogers, Winson, Bibury, Stowell, Yanworth, Compton Abdale, Shipton Oliffe, Hampnett, Hazleton, Salperton, Hawling, Roel, Farmington, Aston Blank and Turkdean are mostly partly on the Fullers' Earth and partly on the basement beds of the Great Oolite; a few are either entirely on the Fullers' Earth or entirely on the Great Oolite; but all are in any case within easy reach of water either by means of wells or from springs. The supplies for Westonbirt, the G.W.R. at Kemble, and Cirencester are obtained from wells or boreholes drawing from fissures in the Great Oolite water which is held up by the subjacent Fullers' Earth.

The Great Oolite, however, is by no means everywhere a sure source of an abundant supply of water: where copious supplies have been met with in wells, headings and boreholes they have been said in all cases to have been encountered in fissures.

Some of the springs thrown out by the Fullers' Earth are very strong: for example, the Seven Springs or 'Wellings' near Northleach; 'Crocodile Spring,' Compton Abdale; 'Well Head,' Shipton Oliffe; those at Winson, Ablington, Bibury and Duntisbourne Abbots; Seven Springs, Bisley; Cherington Springs, near Avening; Twopence Spring, Owlpen; White Well, Hawkesbury; and the Seven Springs, Dodington. Other springs, less copious, in

various parts of the hills have water pumped from them for the supply of villages, mansions, farms, cottages and to troughs for watering the cattle. Bath derives some of its water from numerous springs thrown out by the Fullers' Earth in the St. Catherine's Valley below Marshfield.

The Great Oolite and Fullers' Earth have a prevalent dip in a south-easterly direction. They are, however, not unaffected other than by their general inclination : they are furrowed by numerous valleys and depressions and displaced by many faults. Down some of the valleys flow the main streams which drain the Cotteswold upland above. But the depressions are nearly all dry : the majority of the valleys, if they have any streams in them at all, have them only in their lower reaches ; but where the Great Oolite disappears beneath the Forest Marble strong springs may rise up provided the water-table is maintained sufficiently high. In winter, however, the water-table rises and springs break out, often high up the valleys, giving forth great volumes of water that overflow the banks of the narrow water-courses left for drainage purposes and flood the valley-bottoms. Examples of such intermittent springs—'winterwells' they might almost be called in the Cotteswold Hills—are Winterwell, 3¼ miles north-east by north of Cirencester Church, and Thames Head near Kemble. The seasonal rising of the water-table causes the flooding of depressions below its level, such as Jackaments Bottom—also near Kemble (p. 107).

These valleys and depressions tend to lower the water-table in the contiguous rock-masses, so it will be apparent that before sinking a well or borehole it is advisable to ascertain whether there are any such in the vicinity.

Speaking generally, it would appear safer to obtain water where it is obviously present, as at a spring, and let it gravitate or pump it to the place to be supplied, than to seek it on high ground by means of a well or borehole through a considerable thickness of Great Oolite. Springs thrown out by the Fullers' Earth are usually reliable : they may temporarily decrease in volume, but experience has proved that they seldom fail altogether.[1] Their waters readily deposit their contained carbonate of lime as the deposits they make on the stones, etc., over which they flow, and in pipes that are not kept full (p. 194), demonstrate. W. W. Fisher ascertained by analysis that in the waters from the Great Oolite limestones of the Cotteswolds : "... the total dissolved mineral and saline constituents are about 20 grains per gallon, or even less ; the chlorides are small ; there is little or no ammonia ; while the proportion of organic matter is extremely small. Nitrates, however, are variable in amount, according to the cultivation of the land adjacent to the springs, and often reach a substantial quantity."

It is important for those contemplating sinking a borehole through say the Oxfordian beds to tap water in the underlying

[1] Analyst, vol. xxix, 1904, p. 29.

Oolites to note that Fisher found that "The study of oolitic waters leads to the general conclusion that the uncovered beds of limestone yield calcareous waters of hard character, while the deep beds, especially the beds covered by clay, yield saline or alkaline supplies."[1]

In view of the increasing use that is being made of the springs thrown out by the Fullers' Earth for the purpose of water-supplies, attention must be drawn to the fact that the Great Oolite is rent by many fissures, 'lissons,' 'lissens,' or 'lizens,' as they are locally called in the Stroud and Nailsworth districts, and that filth should not be deposited in them, for rain-water, running down them, thereby becomes contaminated and pollutes the subterranean stores from which the springs are fed.

FOREST MARBLE

This series occurs at the surface over a large area in the South and Mid Cotteswolds and varies considerably in the nature and arrangement of its constituent deposits. The lithic characters of the beds in the country around Shipton Moyne (near Tetbury) will be seen on reference to the record of rocks passed through by the borehole at the West Gloucestershire Water Company's site at Shipton Moyne. Nearly their total thickness (maximum in this neighbourhood, about 87 ft.[2]) was penetrated. Speaking generally, in this neighbourhood clayey or shaly deposits occur at the top and bottom of the series, and limestones (many of the well-known blue, shelly Forest Marble type, with thin alternations of clay), in the median portion. Frequently, however, the upper part of this median portion is sandy, and, locally, as at Westonbirt, comprises irregular deposits of loose sand and 'doggers,' which are occasionally fissile. These sandy deposits account for the many 'furzes' in parts of the Tetbury Rural District, and the clay beds for the numerous pools.

Where the bottom clay deposit of the Forest Marble is absent or ill-developed it is often difficult to determine precisely where the Forest Marble ends and the Great Oolite begins. This difficulty is added to by the fact that in the neighbourhood of Kemble, in particular, limestones come in between the undoubted Forest Marble and the true Great Oolite, which one authority would group with the former formation, and another with the latter. The matter is mentioned here because these Kemble Beds are permeable and have been represented on the geological map as Forest Marble, so that whereas from a study of the map clay beds might be expected, the fact is they are wanting, and, in consequence, the area is much more permeable than might be supposed. As the beds are traced

[1] *Ibid.*, p. 39: see also L. Richardson, *Geol. Mag.*, vol. lix, 1922, p. 355.

[2] See Prof. S. H. Reynolds and Dr. A. Vaughan, *Quart. Journ. Geol. Soc.*, vol. lviii, 1902, p. 749.

north-eastwards they are found to vary considerably, but clay deposits, often thin, are always present.

The clay beds hold up or throw out water from the associated limestone and sandy beds. Badminton, Didmarton, Leighterton, Shipton Moyne, Tetbury, Beverstone, Cherington, Kemble, the Ampneys, Barnsley, Hatherop and Eastleach Turville are all in part or whole on the Forest Marble. The supplies, however, are limited (sufficient for scattered houses, but seldom for groups), frequently run low in times of drought, and the waters in the shallow wells soon become polluted if the wells are insufficiently protected: in brief, the Forest Marble series is not a satisfactory source of supply along its outcrop according to modern requirements. With the exception of Leighterton, Beverstone and Barnsley, all the places named above have piped supplies available, and many of the large houses, isolated farms and cottages have supplies provided from deep borings or from springs at a distance. Wor Well, near Tetbury, the source of the Bristol Avon, is a spring issuing from the Forest Marble (p. 35).

CORNBRASH

The Cornbrash crops out from beneath the Oxfordian along a relatively narrow tract of country between near Pool Keynes and the county-boundary east of Southrop.

The formation consists of 13 to 16 ft. of tough irregular layers of earthy and shelly limestone alternating with softer beds of pasty limestone and with partings and bands of marly or sandy clay; occasionally the limestone is sandy.

When unweathered the rock is bluish and in cores drawn from boreholes difficult to distinguish in the absence of fossils from the blue limestones of the Forest Marble. Such was the case with cores drawn at Lewis Lane (Cirencester) and Calcutt (near Cricklade).[1]

Pool Keynes, Siddington (part), Driffield, Poulton (greater part), Fairford and Southrop are all situate on Cornbrash, and originally depended for their water on shallow wells sunk therein. The evidence obtainable in Gloucestershire indicates that water is fairly plentiful in the beds along their outcrop, and probably for some way beneath the capping of Oxfordian beds, but not far, as the Calcutt Boring demonstrated.

The Cornbrash rests on the Forest Marble, which holds up the water in the Cornbrash along its outcrop. The Oakwell Springs, near Pool Keynes, from which the main supply for the village is obtained (p. 134); in my opinion the Boxwell Springs, near South Cerney; and the spring at Fairford Old Mill (at the south-western corner of Fairford Park), which is the source of the public supply to Fairford, all issue from the Cornbrash. Springs of like origin occur near Barrow Elm and Far Hill, between Fairford and Southrop.

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[1] *Geol. Mag.*, vol. lix, 1922, p. 355.

OXFORD CLAY AND KELLAWAYS BEDS

This Oxfordian Series consists of:

		Thickness Ft.
Oxford Clay	Clays, but more usually shales in the lower portion, in Gloucestershire not exceeding in thickness	193½
Kellaways Beds	Inconstant deposits of fine-grained sand, calcareous sandstone (often extremely hard and in the form of 'doggers'), with alternating deposits of clay or loam	56½
	Clay	up to 18

The beds are met with between Pool Keynes, near Kemble, and the Oxfordshire boundary east of Lechlade; while a small outlying mass, faulted in, was passed through by the borings at the Pumping Station of the Cirencester Urban District Council at Lewis Lane, Cirencester. The thicknesses given above are those that were ascertained from a boring at Calcutt, near Cricklade, Wiltshire,[1] and would not be exceeded in the Gloucestershire tract.

So far as Gloucestershire is concerned the Kellaways Beds are not important from a water-supply standpoint except at South Cerney. In the Calcutt boring they yielded 30 gallons an hour, and the water was saline.

The Oxford Clay is not a formation in which to search for water. Such limited quantities as would be obtained would be likely to be of saline character. Fortunately, however, the extensive tract where it occurs at the surface has gravel, from which adequate supplies of water are obtainable, distributed over the greater portion of it.

Deep borings made through the Oxford Clay and Kellaways Beds with the object of tapping water in the underlying Oolites are also speculative projects, because, as W. W. Fisher demonstrated and the Calcutt boring confirmed, though water may be fresh where it occurs near the outcrop of the Oolite limestones, it increases in salinity away from the outcrop.

G. J. Churchward, the Engineer of the Great Western Railway, informed Fisher that he had tested by borings the waters beneath the Oxford Clay from Swindon to Kemble and had found them to become decreasingly saline until within 1·6 of a mile of Kemble Station.[2]

SUPERFICIAL DEPOSITS

The Superficial Deposits are the accumulations of gravel, sand, etc. They are most in evidence on the surface of the Oxford Clay of the Upper Thames basin, on that of the Lower Lias of the Severn Valley and Vale of Moreton, and to a less extent on that of the Keuper Marl, of the Severn Valley. Locally, deposits of gravel

[1] *Geol. Mag.*, vol. lix, 1922, p. 355.
[2] Fisher, W. W., *Analyst*, vol. xxix, No. 35, Feb., 1904, p. 37.

are found up the river valleys in the Cotteswold upland above the limits of the Oxford clay tracts.

On the Oxford Clay tract between Pool Keynes and Lechlade the gravel is composed principally of well waterworn fragments of Lower Oolitic rocks ('Oolite Gravel'), mostly brought down by the rivers draining the predominantly limestone country of the Cotteswolds. This gravel attains rarely a thickness of 18 ft., but as a rule does not exceed by much 10 ft. It contains abundant supplies of water.

On the Lower Lias of the vale the Superficial Deposits comprise :—1. Gravel, near the hills composed of moderately waterworn fragments of mostly Oolitic, less commonly, Liassic limestones ; in the mouths of the larger valleys (as at Cainscross) more waterworn ; and farther out in the Vale (as at Frome Bridge and near Frampton-on-Severn) well waterworn. 2. Yellow sand (Cheltenham Sands[1]), in some localities pure quartzose sand, in others with a varying admixture of gravel (composed in most places mainly of fragments of Oolitic limestone, less commonly of Liassic limestones). The greatest thickness of this deposit noted as yet is at Charlton Kings—50 ft. + (p. 179).

As in the case of the Oxford Clay tract, so in that of the Lower Lias, all the villages—with one or two unimportant exceptions—are situate, or certainly originated on, deposits of sand or gravel. The deposits are full of water—in some places running out as springs—which yielded satisfactory supplies for the early requirements of the villages. Laxity in matters of sewage disposal, however, has often brought condemnation of the local sources of supply and necessitated water being piped from a distance. The *growth* of a village has also made it necessary in many cases to seek a more abundant supply from further afield.

On the Keuper Marl of the vale to the west of the Severn, on certain hills composed of Lower Lias near the Severn, and on the Lower Lias of the Vale of Moreton, the important superficial deposits from the present standpoint are :—3. Gravel and sand ('Northern Drift') composed of pebbles of quartzite, quartz and many other rocks, and reddish sand, introduced from the north—the bulk having been derived from the Bunter Pebble Beds and Sandstones of the Midlands.

This 'Northern Drift,' as it has long been called in Gloucestershire, is relatively thick in parts of the Vale of Moreton ; but thin, except on certain hill-tops (such as Limbury Hill), on the Keuper Marl to the west of the Severn, where it does not play an important part in the matter of water-supply, most of the villages being dependent on wells sunk in the Keuper Marl.

On the lower ground of the Severn Valley, between the tracts in which undisturbed accumulations of types 1, 2 and 3 of the Superficial Deposits occur, is found a certain mingling of all three, usually

[1] Gray, J. W., *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 3, 1913, p. 370.

of 2 and 3, probably because there has been a certain redistribution owing to the local lowering of the valley-floor since they were deposited.

Useful supplies of water have been and still may be obtained from the Superficial Deposits of the county for isolated mansions, farms and cottages, and even for groups of buildings. Also, wells have been sunk in seemingly Lower Lias only, but have incised a 'vein' or 'pocket' of gravel and have obtained supplies of good, not saline, but hard water.

ALLUVIUM

The most extensive tract of Alluvium in Gloucestershire is that between (near) Sharpness and the Bristol Avon—the Severn Flats, which extend from (near) Sharpness, by Hill and Rockhampton to Oldbury; and from Northwick by Compton Greenfield to the Avon. It is drained by rheens and pills, and contains layers of peat; Bristow noticed one 3 to 4 in. thick at a depth of 12 to 14 ft. from the surface. The Alluvium in this area is full of water of very indifferent quality, mainly on account of the presence of organic matter. In consequence, more populous parts, such as Pilning, Redwick, Northwick and Avonmouth, have to have water laid on from a distance: the first three places from the West Gloucestershire Water Company's supply, the last from the Bristol Waterworks.

Higher up the Severn, between Gloucester and Tewkesbury, the water from the few wells in the Alluvium is usually equally indifferent in quality; but the chief trouble is to prevent the inflow of river-water in times of flood.

SWALLOW-HOLES

The writer knows of only two genuine Swallow-Holes in the Oolitic Rocks of the Cotteswold Hills: one is situated above the letter 'N' in 'Needlehole' on the 1-inch map (n.s.) Sheet 235, in Coberley parish; the other is close to the railway near Oak Well in Pool Keynes parish, Cirencester Rural District.

That near Needlehole is a depression, triangular in plan. Each of its sides is about 40 ft. in length; they slope and narrow downwards. The lowest portion of the depression is circular (6 ft. diameter) and is some 12 to 15 ft. below surface-level. Into this depression water was trickling, when I was at the locality, from three separate sources. The water runs off Fullers' Earth, has established a channel through the bottom of it, and flows down into the subjacent Inferior Oolite and such Cotteswold Sands as are present, and eventually, together with that held up by the underlying Upper Lias Clay, flows in the direction of the slope of the clay-surface, until it finds an outlet into the Churn.[1]

[1] Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xiii, pt. 1, 1912, p. 66.

That near Oak Well is spoken of locally as a Swallow-Hole. Here water sinks into some Cornbrash resting on Forest Marble, but not deeply, and an occupant of one of the cottages at Oak Well said that in wet weather one of the springs bore out in its waters, bits of twigs, etc., which in his opinion had been washed in at the Swallow-Hole.

Carboniferous Limestone, wherever it occurs, is much cut up by bedding-planes, joints, and fissures. In these, underground water circulates, and, by solution and removal of the soluble matter, enlarges the openings. In places these enlarged openings are developed into caverns and through either fissures or caverns the water often travels long distances. The moral is that a source of the water desired for a supply of drinking-water that emerges from Carboniferous Limestone should first be ascertained to be free from pollution before any works are undertaken.

In the Forest of Dean, or to be precise, on the outskirts of the Royal Forest, there are certain very impressive examples of water disappearing down 'Swallow-Holes' and pursuing an underground course. The Swallow-Holes in question are three in number—two, close together, immediately north of Joyford, but just within English Bicknor parish; one at Hoarthorns, a little over half a mile to the east, but just within West Dean parish. For convenience the three are discussed together.[1]

Joyford Swallow-Holes, close together, are situate in a small wood in a shallow valley that deepens when followed from Joyford to the north-east.

A brook draining a depression in the Coal Measures between Joyford and Short Standing flows north-eastward into the wood referred to and drops vertically down a Swallow-Hole best likened to a draw well. It is through sandstone. It is a little difficult to find and should be sought for with caution.

Another brook, likewise draining a depression in Coal Measures, heads from Ninewells, flows north by west, turns at the east-north-east end of the small wood abruptly west-south-west, passes through part of the small wood, and then cascades down into a relatively large, precipitously-sided hole some 30 ft. deep through sandstone, which is not inappropriately called by the natives 'The Wet Sink.' At the bottom the water turns abruptly eastwards and disappears down a cleft.

The sandstone referred to above rests on the Carboniferous Limestone and the waters of the two brooks doubtless mingle in a common fissure in the subjacent Carboniferous Limestone.

Proceeding now down the valley the observer will notice iron railings enclosing a hole under the hedge just before a barn is reached. Water from a small spring trickles down into this hole

[1] For a detailed account see Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 1 for 1924, 1925, pp. 29-31, and pls. iv and v.

and disappears. The hole is called a 'Whirley Hole' by the natives: in the Mendip Hills it would be known as a 'Swallow Hole,' 'Swallet,' or, less frequently, a 'Slocker.'

The valley for some distance below the Swallow and Whirley Holes is quite dry—streamless; but it appears obvious that before the brooks found a way down the Joyford Swallow-Holes their waters flowed Wye-wards down this valley.

Continuing down this now dry valley the observer will enter Brooks Head Grove. Here he will see another valley coming from Hoarthorns.

A streamlet flows down inside the western boundary of Hoarthorns Wood (near Hoarthorns Farm, Edge End) and into a hollow known as Hoarthorns Swallow-Hole, just outside the northern extremity of the wood. Another streamlet comes towards the hollow from the east. Both streamlets spring from Coal Measures and once both disappeared in this swallow-hole. Some years ago, however, their waters were collected and piped to a point further down the valley because it was thought possible that they might emerge in 'The New Pit,' Cannop Colliery. W. H. Davis, Sanitary Inspector, West Dean Rural District Council, obtained some definite information on the matter: he wrote me:—"Immediately prior to the War (1914), green colouring matter was put into the large hole on Good Friday morning and water containing green colouring matter was pumped from Cannop Pit on the Easter Monday morning." This connection, however, J. J. Joynes, the Manager of Cannop Colliery, informs me, was never conclusively proved.

The interesting question is, where does the water that disappears in the Joyford Swallow-Holes emerge? The evidence given below indicates that it emerges in the bed of the River Wye at The Slaughter, about a mile down the valley from Symonds Yat Station.

An experiment was made some years ago—about the time of sinking of "The New Pit"—to ascertain where the water emerged. The water as it disappeared in the Swallow-Holes at Joyford was liberally coloured with ochre and the discoloured water was observed to rise in the waters of the Wye at The Slaughter. The making of this experiment is widely known in the district.

An occurrence not widely known is this: some thirty years ago a considerable volume of water was released suddenly from an old coal-working at Joyford. The water poured down the Swallow-Holes. A man fishing in the Wye at The Slaughter was surprised by a sudden great 'boiling up' of dirty water in the Wye; but subsequently effect and cause were connected.

A stream occasionally flows from the direction of Hillersland to below Bicknor Court. It is a stream draining Coal Measures, and when it does flow its waters disappear in a Swallow-Hole, now being filled up, below the Court.

PUMPING INTERFERENCE

In Gloucestershire there have been several cases in which pumping at one place has affected the supply of water in wells or the yield of springs at other places in the vicinity. Those that have come under notice are :—

1.—Thames Head Well (disused). Thames and Severn Canal.

2.—Bromsberrow Pumping Station, Malvern Urban District Council.

3.—Ketford Pumping Station, Gloucester Corporation.

4.—" Newent " Pumping Station (Oxenhall parish), Gloucester Corporation.

5.—Cinderford Waterworks, Greenbottom. Affects yield of St. Anthony's Well in East Dean parish.

6.—Dog Trap Pit (now closed), West Gloucestershire Water Company.

7.—Severn Tunnel Pumping Station, Great Western Railway.

RAINFALL

Particulars of the distribution of rain in space and time over the British Isles, as recorded by close on 5,000 observers in Great Britain and Ireland are now published annually in a book by the Meteorological Office (Air Ministry). This Government Department took over on 24th July, 1919, the work that had previously been done by the British Rainfall Organisation, which published its first volume of *British Rainfall* in 1860. Particulars obtained from 98 stations in Gloucestershire are published in the volume for 1927. Those desiring more detailed information are referred for the Cirencester district to particulars given by J. H. Taunton[1] and Dr. C. Paget Hooker,[2] to ' Gloucestershire Rainfall ' by A. S. Helps[3]; for Cheltenham, by R. Tyler[4] and Dr. J. H. Garrett,[5] and for the climate of the Bristol district to ' Arrowsmith's Dictionary of Bristol,' and to communications by G. F.[6] and W. C. Burder,[7] W. W. Stoddart[8] and R. F. Sturge.[9] Much useful information is given in the Annual Reports of the Medical Officers of Health for the Cities, Borough of Cheltenham, Urban and Rural Districts.

RIVERS

Gloucestershire is situate in portions of the basins of four important rivers—the Severn, Thames, (Bristol) Avon and Wye. The Severn and Thames, in particular, have many tributaries in the

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[1] *Proc. Cotteswold Nat. F. C.*, vol. ix, 1886, p. 52 and folding table.

[2] *Quart. Journ. R. Met. Soc.*, vol. xxix, 1903, pp. 263-282.

[3] *Proc. Cotteswold Nat. F. C.*, vol. xii, 1897, pp. 155-185 and tables.

[4] ' The Climate of Cheltenham during the years 1878-1887,' 8vo, Cheltenham; ' Twenty Years of Cheltenham Weather,' *Chelt. Nat. Sci. Soc.*, 1897.

[5] *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2, 1913, pp. 137-155.

[6] *Proc. Bristol Nat. Soc.* Numerous papers between 1876 and 1891.

[7] The Meteorology of Clifton. 1863. Bristol.

[8] *Proc. Bristol Nat. Soc.*, ser. i, vol. iv, 1870, pp. 40-44.

[9] ' The Weather at Clifton from 1890-1900.' 1901. ' Thirty Years Weather at Bristol from 1860-1889.' 1890.

county. The courses of the main rivers and their tributaries can be readily traced on the 1-inch Ordnance Maps (new series) so are not described in detail in the following pages: the information that is given is that which has been obtained personally or extracted from the writings of others which would not be gleaned from a study of these maps.

Basin of the Severn: main River.—The Severn enters the county at Tewkesbury and leaves it where it merges into the Bristol Channel opposite Avonmouth, 62 miles 7 furlongs below.

High spring tides flow up past Tewkesbury to Upton-on-Severn and affect the level of the water as far up as the tail of Diglis Lock about a mile below Worcester. High water at Tewkesbury on spring tides is about 3 hrs. 45 mins. after Avonmouth. Neap tides flow to between Framilode and Gloucester.

The whole course of the Severn in Gloucestershire is very liable to floods. Floods have been known to rise 18 ft. in 5 hrs. and not infrequently to attain to a height of about 25 ft. above low-water level. The level tracts of Alluvium especially liable to flood may be readily detected: between Avonmouth and Berkeley banks have been thrown up locally to shut out the waters; but above Berkeley they are frequently inundated and any insufficiently-protected wells receive flood-water.

Estimates made of the volume of water flowing down past Tewkesbury and Gloucester vary between 100 million and 250 million gallons per day.[1]

The Severn is drawn upon by the Cheltenham Corporation Waterworks at Tewkesbury (when the supplies from the Cotteswold Hills to the reservoirs are feeble) for the supply of Tewkesbury, Cheltenham and numerous villages in the Vale. There was considerable opposition in Cheltenham to the idea of drinking Severn water, when it was first mooted, from fear that the pollution from sewage discharged into the river or its tributaries higher up would produce disease.

In 1894, Dr. J. H. Garrett, Medical Officer of Health for Cheltenham, read a paper defending its use.[2] He pointed out that although numerous towns did discharge their sewage into the river and its tributaries the quantity in relation to the volume of water in the river was infinitesimal; that it was an undeniable fact that such organic matter was rapidly destroyed in the river water.

The Severn has also been considered as a source of supply for Gloucester. In 1891 William Fox referred to a proposal to pump water from the river at Tewkesbury[3] and in 1893, prepared an estimate for a scheme for pumping water for Gloucester from the Severn "just above the entrance of the Chelt,"[4] but this and numerous other schemes were turned down in favour of that of boring in Oxenhall parish.

A supplementary supply of water for the Gloucester and Berkeley Canal is taken from the Severn just above Llanthony Weir.

Sub-basin of the Stratford Avon.—The Stratford Avon flows but little in Gloucestershire: it merely forms the county-boundary in the parishes of Welford-on-Avon and Twyning. Its waters are not made use of for the purpose of any public supply: they are too loaded with organic matter and hard. The river is full in times of heavy rain and in winter when its waters

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[1] See Hawksley, T., *Select Com. Chelt. Water Bill, Min. of Evidence*, 1st June, 1865, p. 23; J. S. Pickering, *Trans. Inst. Water Eng.*, vol. xviii, 1912, p. 71; and E. D. Marten and G. W. Keeling, *Rep. Royal Comm. Canals and Waterways*, vol. x, 1911, p. 217.

[2] *Proc. Cotteswold Nat. F. C.*, vol. xi, 1894, pp. 118-154.

[3] 'Report of the best means of increasing the Water Supply of the City of Gloucester,' 1st June, 1891, p. 11.

[4] Report, 23rd Aug., 1893, p. 3.

often inundate the alluvial grounds that border it, but in the summer it is low. From a sample of water taken opposite the 'Mytton Turnpike,' presumably a mile or so above Tewkesbury, John Horsley ascertained that a gallon contained 21 grains of solid matter of which 16½ grains were mineral and 4½ grains organic.[1]

The Stratford Avon has, however, several tributaries in part or wholly in Gloucestershire. They are, the River Stour (in part), Gran Brook, Dorsington Brook, the River Isbourne (with many tributaries), and Carrant Brook. They drain the northern portions of the North Cotteswolds and the vale land at their foot. Some of the more copious head-springs of these tributaries, as at Ebrington and in Bourton Woods, are used for the purpose of public supplies; but many of the smaller ones are running to waste.

Minor tributaries of the Severn on its left bank between the basin of the Stratford Avon and that of the next important tributary to be considered, the Stroud Frome, are—the River Swilgate with its tributaries, the Tirle, Dean, Prestbury and Wyman's Brooks; the River Chelt, the headwaters of which from a catchment-area of but 3 square miles are impounded in the Dowdeswell Reservoir (Cheltenham Corporation Waterworks), which discharges into the River Severn at Wainlode; the Hatherley and Horsbere Brooks; and the Twyver and Sud Brooks, which empty into the Severn at Gloucester.

Sub-basin of the (Stroud) Frome.—The Stroud Frome and its tributaries drain a section of the Cotteswold Hills, above Downton Mill, according to J. H. Taunton, 79 square miles in area.

The Frome is an 'obsequent' of the Severn; it and its tributaries are still extending headwards and have deeply incised the upland. The main valley between Stroud and Sapperton is very deep.

The bulk of the water carried off by the Frome is derived from springs issuing from the Cotteswold Sands. Some water is derived from springs thrown out by the Fullers' Earth, but that contributed directly from this source is relatively small.

The chief tributaries of the Frome are, the stream that rises at Clipperwell, Holy Brook, Toadsmoor Brook, Slad Brook, Painswick Stream, River Avon (or Aven) with its tributary the Horsley Brook, Stanley and Downton streams; while in this connection the group of springs known as 'the Chalford Springs' must not be overlooked.

The Avon and Frome receive a certain amount of sewage pollution and the washings from rag, flock, cloth-dyeing and leather-board establishments which naturally greatly discolour the water, and the Frome, in its lower reaches, is very black and turbid. Owing to the very gradual fall there is little chance of self-purification by aeration.

J. H. Taunton made a detailed study of the River Frome and for further particulars the reader is referred to his paper.[2]

Sub-basin of River Cam.—The River Cam drains an area of 18½ square miles and discharges into the Gloucester and Berkeley Canal as a feeder. At Dursley, 'Broadwell' spring contributes its waters. 'Broadwell' is referred to in old writings as 'Ewelm' and the River Cam above it is designated on the six-inch map the 'River Ewelme.'

The bulk of the water collected by the main stream and its tributaries is derived from springs thrown out by the Upper Lias clay: some comes from springs thrown out by the Fullers' Earth and a little issues from the Middle Lias, for example, the spring (chalybeate) near the Dursley Gas Works which is drawn on for the supply of King's Hill.

The headwaters, thrown out by the Upper Lias clay, of a tributary stream are tapped for the supply of Coaley: the Dursley Waterworks taps water,

[1] Wright, Dr. T., and D. J. Humphris, 'Report on the Sources of an Additional Supply of Water to the Town of Cheltenham,' Cheltenham, 1863, p. 30.

[2] *Proc. Cotteswold Nat. F. C.*, vol. ix, pt. for 1885-86 (1886), pp. 62-67.

by means of a well, in the Marlstone near the Caswell Stream. 'Broadwell' is not used for the purpose of any supply: its waters issue in the heart of Dursley.

Sub-basin of the Little Avon River.—The Little Avon River drains an area of 68 square miles. It rises near Horton in an obscure spring thrown out by the Upper Lias clay and enters the Severn 1½ miles west-north-west of Berkeley.

The head waters of the main stream are mostly derived from the surface drainage of the Lower Lias tract, one of the streamlets draining which bears the significant name of 'Saltsmoor Ditch.'

The bulk of the water brought down by the majority of its tributaries is contributed by springs thrown out by the Upper Lias clay. Examples of such springs are those at Upper Kilcot, Seven Springs (Ozleworth), and those up Waterley Bottom. Some water is contributed by springs, such as Whitewell, in Hawkesbury parish, and St. Mary's Well, in Boxwell parish, which are thrown out by the Fullers' Earth. An important contribution is the product of the drainage of the northern extremity of the Bristol Coalfield. This drainage is effected by three streamlets which coalesce east of Cromhall Common. The combined streams form a brook that flows to Tapwell Bridge, whence as 'Dyers Brook' it flows through Tortworth Lake to the Little Avon at Middlemill. Dr. F. S. Wallis informs me that the name 'Dyer's Brook' apparently refers only to the portion of the stream between Tapwell Bridge and Tortworth Lake; the portion between the Lake and the Little Avon is locally called the 'Tortworth Stream.'

Water from springs thrown out by the Fullers' Earth is taken for the part supply of Wotton-under-Edge, for Tresham, and for certain private supplies (as at The Ridge, Lasborough and Boxwell); and from springs thrown out by the Upper Lias clay for the part supply of Wotton-under-Edge, for Kingswood (at Sinwell), Alderley (at Monk's Mill), and Hillsley.

Sub-basin of the Leadon.—The River Leadon rises near Evesbatch in Herefordshire, 6 miles west of Malvern Link Station (Worcs.), and enters the Severn at Over, near Gloucester. The area of the portion of its basin in Gloucestershire is 60 square miles.

The chief tributaries of the Leadon in Gloucestershire are the Preston and Ell Brooks: the Glynch Brook is mainly a Worcestershire stream.

The New Red Sandstone tract traversed by the Glynch Brook, River Leadon and Ell Brook is for the most part elevated and pleasingly diversified with valleys which are mainly dry in their upper reaches. The reason for their dryness is the porosity of the sandstone which readily absorbs water. In consequence the sandstone is full of water, and this fact has been made use of by the Malvern Urban District Council, who have three boreholes (all 200 ft. deep) in the sandstone at Bromsberrow Heath, and by the Gloucester Corporation who have two boreholes (respectively 359 ft. and 447½ ft. deep) at Ketford and a well (168 ft. deep) at their 'Newent' Pumping Station in Oxenhall parish.

There are few springs in this sandstone tract: such as there are are mostly towards its eastern limit, and it is interesting to note that some of these, as in the valley of the Ell Brook (Newent Spa) and of the River Leadon near Durbridge, are very "salty," and others, in the valley of the Leadon (also near Durbridge), sulphurous (Pauntley Spa).

A number of streams originate from the Silurian and Old Red Sandstone of the May Hill district: it was once suggested that the waters of one or more of these should be impounded near Byfords to augment the supply of the City of Gloucester, but the proposal was turned down.

The Ley Brook rises in a depression in the Wenlock Shales near Little London in the May Hill area, but its course is often dry down to the 'Royal Spring,' Little London. It enters the Severn at Denny Hill, a mile or so to the south-west of Minsterworth. A tributary streamlet drains the deep valley

between Bright's and Huntley Hills (May Hill area) and a suggestion was once made that its waters should be impounded where Woodend Farm now stands to serve as an additional supply to the City of Gloucester.

Sub-basin of the Westbury Brook.—The Gloucestershire country between May Hill and the Forest of Dean is drained by the Westbury Brook and its tributary the Longhope Brook. The area of the sub-basin of the Westbury Brook is 14½ square miles, and is for the most part on Old Red Sandstone.

The Westbury Brook rises at Seeving Well, Plump Hill, flows down Horsepool Bottom to Gunn's Mill (disused). Here it receives the waters of the important spring at St. Anthony's Well and smaller springs. The spring at St. Anthony's Well issues from the quartz-conglomerates of the Upper Series of the Old Red Sandstone near the foot of a steep hill-side which is crowned with Carboniferous Limestone. The yield of St. Anthony's Well spring on 8th October, 1922, was about 200,000 gallons a day. A little below the stream is impounded at Gunn's Mills, where, on the same day, its flow was 300,000 gallons a day.

Close to Gunn's Mill by the side of the road to Little Dean is Borden's Spring, also issuing from the Old Red Sandstone. The yield of St. Anthony's Well spring is said to be affected by pumping at the Cinderford Waterworks in Greenbottom, a quarter of a mile to the south.

The Longhope Brook has an obscure source towards the foot of the western slope of May Hill. It receives little water from the Silurian tract of the May Hill area on its left bank: the bulk of it comes in on its right bank from eastward-flowing streamlets draining the ridge and valley country composed of the westward-dipping Old Red Sandstone. The principal tributary stream is that from Mitcheldean, the head-spring of which, thrown out by the Lower Limestone Shales, has been utilized by the Mitcheldean Waterworks Co., Ltd. A spring by the side of the stream between the Wilderness Brick Works and Barton Hill Quarry has its waters forced up by a ram to supplement the supply to the Forest Brewery, Mitcheldean.

Sub-basins of Soudley, Blackpool and Cannop Brooks.—These three brooks carry off to the Severn the bulk of the drainage of the Forest of Dean. Their drainage-areas are:—

Soudley and Blackpool Brooks	19 square miles
Cannop Brook	20 ,, ,,

The Soudley and Blackpool Brooks coalesce at Blakeney.

The Soudley Brook above Ruspidge derives the bulk of its water from the drainage of Coal Measures. At Silly Point, Shakemantle, a strong spring contributes waters draining out of the Carboniferous Limestone. Below Soudley numerous streamlets collecting water from springs issuing from the Old Red Sandstone discharge into the brook, here called the 'Forge Brook.'

The Blackpool Brook derives its headwaters from a multitude of streamlets draining Coal Measures. North of Danby Lodge it cuts through the Carboniferous Limestone and enters the Old Red Sandstone tract, across which it continues to its junction with the Forge Brook. The Old Red Sandstone is full of water: at Blackpool Bridge a boring has been made in it in connection with a scheme for the supply of West Dean; while a mile or so lower down a spring (Old Woman) issuing from it is utilized for the supply of Blakeney Hill and district.

The Cannop Brook, less frequently called 'The Lydd,' rises in Serridge Enclosure, flows through the Cannop Pools (near which is Cannop Colliery from which 2,000 gallons of water are pumped per minute), breaks through the rim of the Coalfield in the part from which the Drybrook Sandstone and Carboniferous Limestone are absent, and discharges into the Severn below Lydney.

Basin of the Wye: main River.—Only 34 square miles of Gloucestershire comes within the Wye basin and the streams draining the tract and running

into the main river are short and small. The principal brooks are the Lydd and Valley Brooks. The former is the outlet of a considerable volume of water from the Carboniferous Limestone of the neighbourhood of Upper Lydbrook; the latter rises on the Coal Measures above Coleford, flows through a valley in the Carboniferous Limestone at Whitecliff, receives the waters from the well-known Clearwell Spring and passes on to the Wye by way of Newland. At the foot of Ban-y-gor Cliff a strong spring which enters the river and drains part of the tract composed of synclinally-arranged Carboniferous Limestone strata is drawn on for the supply of Tidenham, Tutshill and Woodcroft.

On the right bank of the Severn between Tewkesbury and the sub-basin of the River Leadon only unimportant streamlets drain such tracts as are in Gloucestershire.

Basin of the (Bristol) Avon: main River.—The Bristol Avon separates into two branches above Malmesbury—the Sherston Branch and the Tetbury Branch, the areas of whose basins are 38½ square miles and 39 square miles respectively. Of the basin of the Sherston Branch 22½ square miles is in Wiltshire, and 16 square miles in Gloucestershire. Joyce Pool, Didmarton, is regarded by some as a source of the Avon, but the main outburst of water is lower down, at Cow Down Springs, in Wiltshire. The Tetbury Branch rises at Wor Well, a spring issuing from the Forest Marble a mile north-east by east of Tetbury Church. Its waters have been tapped for the supply of the house called 'Hillsome,' and the river-course is usually dry for some distance below. Water gradually makes its appearance, flows through the lakes at Estcourt (near which is a well from which water is raised for the supply of Long Newton and Shipton Moyne), and leaves the county at Fosse Bridge. This Tetbury Branch has a basin-area in Gloucestershire of 31 square miles, and in Wiltshire of 8 square miles. The greater part of the basin is on Forest Marble and there are few tributary streams. There are numerous usually dry valleys, some of which are sunken through the Forest Marble into the Great Oolite. These valleys have caused the lowering of the water-table in the Great Oolite, with the result that boreholes are the only means of obtaining an adequate supply of water. In this basin are boreholes at Chavenage, Upton Grove, Upton House, Tetbury (Urban District Council's Waterworks), Shipton Moyne (West Gloucestershire Water Company—in abeyance), Westonbirt, 'Leighterton Aerodrome' (disused).

The Tetbury and Sherston Branches of the Avon join at Malmesbury and thence the Avon pursues its circuitous journey through Wiltshire, by way of Chippenham, Melksham, Bradford-on-Avon and Bath, entering Gloucestershire again near Bitton, whence it forms the county-boundary to its embouchure in the Bristol Channel at Avonmouth.

Certain brooks flowing into the Avon in the neighbourhood of Bath derive some of their headwaters from Gloucestershire. A large number of springs in Gloucestershire, south of Marshfield, which formerly contributed their waters to the St. Catherine's Brook, have been collected for the part supply of Bath.

Below Bitton the Avon receives the waters of the River Boyd and within the City of Bristol boundary of the Rivers Frome and Trym—the latter at Sea Mills.

Sub-basin of the Boyd.—The area of the sub-basin of the River Boyd is 20 square miles, of which about 1 square mile, around North Stoke, is in Somerset. The river rises at Springs Farm, south of Dodington, but in the civil parish of Wapley and Codrington, and in wet weather further to the north-east and but half-a-mile distant from the source of the (Bristol) Frome—the Seven Springs in Dodington Park. 'In wet weather,' it is stated, because then water running off the Fullers' Earth, down a rugged course sunken in the Cotteswold Sands, constitutes its source; but in normal weather, a spring issuing from the base of the Sands on the north side of the road at the foot of Green Hill, a little to the north-east of Springs Farm, is its

true source. Locally, however, the strong spring issuing at the well which supplies Springs Farm is regarded as its source.

The river is of little interest from a water-supply standpoint and in dry periods its volume is greatly diminished. Its waters, however, are utilized at the Ochre Works at Wick and the paper mill at Bitton.

Sub-basin of the (Bristol) Frome.—The area of the sub-basin of the River Frome is 67½ square miles. The river rises at the Seven Springs, thrown out by the Fullers' Earth, in Dodington Park, and drains the greater part of the Bristol Coalfield. The Pennant Grit between the Transition and the Upper Coal Measures is full of water and therefrom, from old pits at Frampton Cotterell, Cowhorn Hill (in Bitton parish) and California (in Oldland parish), the West Gloucestershire Water Company derives its supplies. Mining operations, as in the Forest of Dean, have, however, lowered the water-level in the Coal Measures of this sub-basin, which accounts for the net-work of pipes, belonging to this Company, that cover the district. H. W. Pearson wrote :—" In the watershed and valley of the Frome, the water-logging of the Pennant Grit and Upper Coal-measures and surrounding sandstone gives a very large percentage of percolation equal to fifty per cent.,[1] which results during heavy rainfall in the water shedding off almost bodily into the Frome, and so producing disastrous floods."[2]

Basin of the Thames : main River.—The true source of the River Thames is in the valley between Kemble and Coates, but it has not a fixed location. It moves up and down the valley. I have been shown four ' true sources ' :

1. In Trewsbury Mead near the foot of the western bank of the disused Thames and Severn Canal, 750 yards up the valley above the bridge—known as ' Thames Head Bridge '—that carries the Fosse Way over the canal.[3]

2. On the south side and at the foot of the retaining wall of the Fosse Way embankment—close to Thames Head Bridge.

3. In the field a little in advance of the retaining bank of the canal about halfway between Thames Head Bridge and the disused Pumping Station of the old Thames and Severn Canal, which has been pictured as the ' source ' in an old print of 1810.

4. Lyd Well, which is situate some 500 yards south-east of the Pumping Station.

On 4th January, 1923, the stream down the valley had its origin in a spring at the foot of the canal bank near Coatsfield Bridge some 600 yards higher up the valley than the source (1) in Trewsbury Mead. This makes a fifth source, and no doubt their number could be added to, for the position of the source depends on the altitude of the water-table in the permeable and much fissured Great Oolite rocks.[4]

The geologic structure of the Thames Head district is :

1. Forest Marble (mostly impervious), resting on
2. Great Oolite (permeable and much-fissured, ascertained during the construction of the G.W.R. Sapperton Tunnel to be about 150 ft. thick), and this in turn on
3. Fullers' Earth (impervious).

These formations have been inclined in a south-easterly direction, faulted, planed and sculptured by denudation with the present-day result that the Great Oolite occurs locally at the surface and the whole district is furrowed by numerous valleys. The principal valley is that between Coatsfield Bridge and Lyd Well—that in which the Thames has its genesis.

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[1] See also E. B. Wethered, *Proc. Bristol Nat. Soc.*, vol. iv, pt. 1, 1883, p. 17.

[2] *Proc. Bristol Nat. Soc.*, n.s., vol. vi, 1890, p. 330.

[3] Cf. H. B. Woodward, ' The Jurassic Rocks of Britain ' (*Mem. Geol. Surv.*), vol. iv, 1984, p. 509.

[4] See also J. Phillips, ' Geology of Oxford,' 1871, p. 26.

In consequence of the inclination of the rocks being at a greater angle than that of the slope of the country, the Great Oolite dips down to the south-east and disappears beneath the Forest Marble. Between the Fosse Way and Lyd Well, however, the young Thames has excavated a valley through the Forest Marble into the Great Oolite, so that the boundaries at the surface of the Great Oolite may be roughly represented by the letter U—the Great Oolite inside (in the valley) and the Forest Marble outside. This U points south-eastwards. Water absorbed by the Great Oolite to the north-west and north gravitates under-ground to the south-east and its last place of escape, before being shut down by the Forest Marble, is up through the Great Oolite at the bottom of the U. Here is Lyd Well. Water ceases to flow over the lip of Lyd Well only between May and September: one year only for a part of July. Cessation of flow over the lip of the well is due, of course, to the water-table in the Great Oolite falling below the level of the lip of the well. As the water-table rises the water 'boils up' out of Lyd Well in increasing velocity and volume, and springs 'break' successively higher up the valley.[1]

The section of the Thames from its source to Lechlade Bridge is 18 miles in length. From its source to about half-way between Somerford and Ashton Keynes it is in Gloucestershire; but thence onwards, owing to the irregular nature of the boundary between Gloucestershire and Wiltshire, its course traverses first one county and then the other.

Tributaries of the Thames are the Churn, the Coln, the Leach, the Ampney Brook, the Windrush (which drains the greater part of the North Cotteswolds) and the Evenlode.

The head-waters of the Thames as a potential source of supply were considered in detail by the Royal Commission, appointed in 1869, to investigate the question of water-supply. John Bravender,[2] J. H. Taunton[3] and Robert Etheridge[4] have also written on them from the same standpoint.

Sub-basin of the Evenlode.—The area of the basin of the Evenlode above Bledington is 54¾ square miles: of that portion in Gloucestershire, 27¼ square miles. The river itself is slow-flowing, and in the Gloucestershire portion of its basin sources of water are comparatively few and limited in yield. This is because the greater portion is on Lower Lias clay and the prevalent dip of the water-bearing beds in the hills is away from the vale, in the direction of adjacent river-basins on the west. Springs do issue from the hill-sides, however, and have determined the sites of Batsford, Bourton-on-the-Hill, Longborough, Broadwell, Stow-on-the-Wold, Oddington, Iccomb and Westcote, at all of which places the best are made use of for the purpose of supply. Stow-on-the-Wold originally obtained its water from the 'wells' on the Broadwell Road, but now from the Urban District Council's well in the town which is sunk through the Oolites approximately on the divide between the Evenlode and Dikler basins.

The Lower Lias of the Moreton valley is locally covered with Glacial deposits—sand, gravel and boulder clay. Moreton in Marsh originally obtained its water from wells sunk into the gravel (but it became necessary eventually to go into the valley of the Dikler for a reliable supply) and Bledington still does.

Sub-basin of the Windrush.—The Windrush, which has a basin area (including the basins of its tributaries the Rivers Dikler and Eye and Sherborne Brook) in Gloucestershire of 85¼ square miles, rises near Taddington in

[1] Richardson, L., 'Thames Head,' *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), pp. 161-166, and pls. vi and vii. See also *idem.*, vol. xxii, pt. 1 for 1924, 1925, pp. 17, 18; also *Proc. Geol. Assoc.*, vol. xxxvi, 1925, pp. 85, 86.

[2] *Rep. Roy. Comm. Water Supply*, 1869, Appendix H, p. 42, and *Proc. Cotteswold Nat. F. C.*, vol. iv, 1867, pp. 242-45.

[3] *Rep. Roy. Comm. Water Supply*, 1869, Appendix BJ, p. 125, and *Proc. Cotteswold Nat. F. C.*, vol ix, 1886, pp. 53-6.

[4] *Proc. Cotteswold Nat. F. C.*, vol. xi, 1893, pp. 53-55.

Stanway parish, in a valley into which a Severn-System stream is working headwards from the north. Together with its tributaries it drains the greater part of the North Cotteswolds, deriving the bulk of its water from springs thrown out by the Upper Lias clay and Fullers' Earth. Between the Upper Lias clay and Fullers' Earth is a great mass of permeable rock, the Inferior Oolite and locally Cotteswold Sands. Except in or after wet weather, when the water-table is above the valley-bottoms, the water-courses where they traverse the outcrops of the Inferior Oolite and Sands are dry. Numerous faults displace the rocks, and in valley-bottoms where they have resulted in impermeable beds being in juxtaposition with permeable, the phenomenon may be witnesssed of streams with interrupted flow.

The River Windrush has a basin area (not including the basin areas of the tributaries mentioned) to the county boundary, including ¾ square mile in Worcestershire, of 29 square miles.

At Guiting Power the Windrush is joined by the stream that rises at Slade Barn, which receives the waters of the streamlet heading from the direction of Lyne's Barn, of the springs at Broadwater, and of that, such as is surplus to the requirements of the village, at Guiting Power. Lower down the Hawling Brook joins it on its right bank, and on its left bank it receives such waters as are not taken for the purpose of supplies at Temple Guiting, Kineton, and Naunton, of the Seven Springs between Harford Bridge and Bourton-on-the-Water, and, below Bourton, of the River Dikler. Before turning eastwards at the southern end of the Vale of Bourton it receives the waters of the Sherborne Brook, a short (2½ miles) stream, but powerful, contributing the drainage of 22½ square miles of country.

The perennial source of the River Dikler is just below Waterhead Barn, 2 miles north-west from Stow-on-the-Wold. The drainage-area of the river is 22 square miles but of this 11·25 square miles lie above the perennial source. The main valley commences indistinctly a little to the south-eastward of 'The Fish' inn on Broadway Hill. All the head-springs above the Bourton Road Lodge of Springhill are perched gravity springs thrown out by the Snowshill Clay, the waters of which sink into the Inferior Oolite. The valley between the Lodge and Hinchwick has, as a rule, been excavated down to the Upper Lias clay and for a stretch of about a mile and a half above Hinchwick there is a perennial stream that has been impounded in its lower portion to form the Hinchwick Pools. At Hinchwick a fault, with a considerable throw, crosses the valley and lets down a great mass of permeable Oolites against the Upper Lias clay. The result is that the stream disappears at Hinchwick into the Oolites and does not re-appear until the Upper Lias clay emerges and throws it out near Waterhead Barn. When after rainy periods the water-table rises above the level of the permeable Oolites and aggraded rock-matter in the valley-bottom a continuous stream flows down the valley-bottom from 'Far' Upton Wold, and, at times, across the road in Luckley Bottom.[1]

The River Eye is a tributary of the Dikler. Its drainage basin is 11¾ square miles, and of this 7¼ square miles is situate above its perennial source near the 'Roaring Wells' on the outskirts of Eyford Park. From a short distance above the perennial source of the river its drainage basin is composed of much-faulted, principally permeable rocks, furrowed with many generally streamless valleys. The main valley commences near Trafalgar Farm. About a quarter of a mile eastward from the farm two springs are thrown out by the Snowshill Clay. Their waters would have been at once lost by influent seepage into the permeable Inferior Oolite had it not been that they have been conducted into a cement-lined pond. The overflow, however, disappears. Thence the valley is normally streamless down to a point about half a mile south-westward from Fox Farm. From here on 10th November,

[1] For a detailed description of the River Dikler see Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2 for 1925 (1926), pp. 179-181.

1925, a streamlet with locally raised banks was running as far as a point about a quarter of a mile S.S.E. of Swell Wold Farm where the water sank into the ground. Thence the valley is as a rule streamless down to where the Upper Lias clay emerges and throws out the perennial source near the 'Roaring Wells.' In Eyford Park the valley of the Eye is locally very steep-sided and contains, on the line of the river, The Lake. On the east bank of the river, half-way between The Lake and the Cheltenham-Stow road is Milton's Well—a good spring thrown out by the Upper Lias clay that maintains the well and supplies Eyford Park, etc. From hereabout downward the Eye is known locally as the 'Slaughter Brook.'[1]

The Sherborne Brook has a basin area of 22½ square miles.[2] Normally this stream rises a mile or so west of Sherborne; but what is properly its valley commences in a depression on the north side of the Cheltenham-Stow road at about three-quarters of a mile southward of Hawling.

North of a line joining Notgrove and Salperton a number of faults are shown on the Geological Survey Map which traverse the country in an east and west direction. South of this line there are probably minor faults that are not shown on the map, but faults and flexings have produced a bed for the stream at some places over permeable Inferior Oolite and at others over permeable Sands with Upper Lias clay not far below. It will be apparent then that in dry periods the stream, in its natural condition, would be likely to be an 'interrupted stream'—that is, composed of perennial stretches with intermittent stretches—until it reached the locality at which the main outcrop of the Upper Lias clay is encountered. As a rule, however, a very diminutive stream is continuous from near Slade Barn down to 220 yards east of the Fosse Way bridge in Broadwater Bottom, the reason being that in times gone by sections of the stream-course over the permeable rocks were puddled to retain the water.

Usually at 220 yards east of the bridge in Broadwater Bottom the water of the streamlet disappears into the Oolite.

Numerous springs are thrown out from the base of the Great Oolite by the underlying Fullers' Earth in the parishes of Salperton, Haselton, Notgrove, Aston Blank, Turkdean and Farmington. Some originate streams that persist to the main brook, but the waters of the smaller ones disappear into the permeable Inferior Oolite very shortly after they have traversed the outcrop of the Fullers' Earth clay.

At about a mile and a quarter below the spot where the streamlet usually disappears a small stream as a rule makes its appearance. It is to be seen entering the western end of a plantation in the bottom of the valley half-a-mile E. by S. of Farmington Church. From the eastern end of the plantation a good stream emerges. The reason is that the Upper Lias clay comes to the surface and throws out the water collected in the drainage basin above which totals about 20 square miles.

From the plantation eastwards the Sherborne Brook flows over clay; rapidly increases in volume owing to the contributions of a number of strong springs; is impounded on its way to form the ornamental sheets of water in Sherborne Park, and joins the River Windrush at a little over three-quarters of a mile to the E. by S.

Sub-basin of the Leach.—The River Leach rises at the Seven Springs, or 'Wellings,' near Northleach, at about 550 ft. O.D., and discharges into the River Thames to the east of Lechlade at about 230 ft. O.D. The area of the Leach basin is 33¾ square miles. The 'Wellings' issue from the basement beds of the Great Oolite from which they are thrown out by the Fullers' Earth.

[1] For a detailed description of the River Eye, see Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 3 for 1926 (1927), pp. 255-258.

[2] For a detailed description of the Sherborne Brook see Richardson, L., 'The Sherborne Brook,' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2 for 1925 (1926), pp. 183-185.

In spite of the quantity of water now taken for the purposes of supplies (see p. 126) from and from near the source of the Leach, a good stream flows off the Fullers' Earth ground on to the Inferior Oolite of the tract on which Northleach is built. As far as can be ascertained without taking gaugings, little water is lost to the stream by percolation into the permeable Inferior Oolite: the stream course appears to be well puddled with matter derived from the Fullers' Earth.

From a little to the north of Upper End, Eastington, to half-way through Lodge Park, the river flows over Fullers' Earth, in a valley which has Great Oolite for its sides. Springs issue from at or near the junction of the two formations, and a number of them—as at Upper End; one-sixth of a mile north of Eastington; and the Arnold Springs in Sally Coppice—are drawn upon for the purposes of supplies.

In Lodge Park the river leaves the impermeable Fullers' Earth to commence its nine-mile journey over the permeable Great Oolite beds. For half a mile or so it flows in an artificial course, constructed for the purpose of supplying a sheep-wash, but thence the volume of water in the stream rapidly diminishes. In September, 1922, water was just moving at the bridge which carries the Cirencester-Aldsworth road over the 'river'; at Cold Swyre, a little below, it was standing in pools; but thence to below Sheepbridge the fine valley was streamless. Springs issue from the lower and basement-beds of the Great Oolite near Woeful Lake Farm; at Wall Farm, Aldsworth; and in Aldsworth village by the side of the streamlet in the dip between the School and the Church; but in September, 1922, none of this water reached the main valley: it all sank into the ground (Great Oolite).

An important fault affects the rocks in the valley below Sheepbridge, and 'holds back' the water to some extent on the north. About a quarter of a mile below Sheepbridge (immediately north of the fault) is a pond in marly beds of the Great Oolite. In September, 1922, water was not actually flowing out of this pond, but there was clear evidence that it had done so recently. Probably this pond marks the normal summer-time re-appearance of water; but in September, 1922, the main outburst was below Smerril Plantation, where a number of springs gave immediate birth to a good stream. Thence onwards the stream rapidly increased in volume, until a fine brook—well worthy of the designation 'river'—flowed between the close-placed churches of Eastleach Turville and Eastleach Martin, under Keble's Bridge, and the road-bridge at Southrop, Thames-wards.

The Leach now flows continuously from source to mouth for but a short time in the winter, when it bursts the banks of the restricted stream course and floods the adjacent valley-bottom. During this period, in particular, a fountain by the river-side at Eastleach Martin belches forth water. But when the water-table in the Great Oolite sinks, a long stretch of valley becomes dry; the fountain runs feebly and at times ceases to yield; while during the drought of 1921, the river itself between the Eastleachs was reduced to a mere streamlet.

As showing how low the water-table falls—that at times, indeed, the Great Oolite is deprived locally of all its water—it may be mentioned (1) that a well sunk about 1908 to a depth of 40 feet near the river-bed at the Dean Farm did not tap any water, and (2) that in the borehole in Sheepbridge Bottom 'no water to speak of' was found above the Fullers' Earth, but that which was tapped by the borehole was encountered in the freestone of the Inferior Oolite.[1]

Sub-basin of the Coln.—The River Coln originates from the surface-drainage of an Upper Lias clay tract to the north of Brockhampton in the

[1] For a detailed account of 'The River Leach' see Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 1 for 1924 (1925), pp. 43-50, and pl. vi.: also *Proc. Geol. Assoc.*, vol. xxxvi, 1925, p. 92.

valley between Winchcomb and Andoversford and enters the Thames close to the junction of the abandoned Thames and Severn Canal with the Thames about half a mile south-west of Lechlade. The area of its basin is 66¼ square miles.

The river is but a streamlet to Syreford and of such springs that feed it, the chief—at Brockhampton (Donny Well) and Sevenhampton—are drawn upon for the purpose of village-supplies. At Syreford are the fine Syreford Springs, which are stated to have yielded as much as 5,000,000 gallons a day. Between Syreford and Andoversford is a valley up which the Chelt is working headwards from the west. The Coln continues to flow over Upper Lias clay as far as Withington, receiving the waters of a number of small springs thrown out by the Upper Lias clay on the west side of the valley, and of a streamlet originating in springs thrown out by the Fullers' Earth near Shipton Oliffe on the east side. At Compton Abdale is a good spring feeding the mill-pond, also the Crocodile Spring from which the supply of the village is taken. Both springs are thrown out by the Fullers' Earth and maintain a stream until its course is across the Inferior Oolite and Cotteswold Sands into which it disappears, little water reaching the main stream. Numerous springs are thrown out by the Fullers' Earth in the neighbourhoods of Stowell and Yanworth, the chief of which are made use of for supplies. Here again little water reaches the main river: the bulk of it soaks into the Inferior Oolite.

Between Fossebridge and Bibury numerous springs issue from the basement-beds of the Great Oolite, from which they are thrown out by the Fullers' Earth. Along this stretch the chief are: Winson Spring (from which water is taken for the supply of Winson and Arlington), Ablington Spring, and Bibury Springs (from which water is taken for the part supply of Bibury and farms away on the high ground). The Bibury Springs would appear to be the product of the drainage of the high grounds (composed of Great Oolite, capped locally with Forest Marble) to the north and north-west; but R. Etheridge says "Between Stowell and Lechlade the only known fault of importance throws out the copious spring of Bibury."

At Coln St. Aldwyn water is pumped out of the river and filtered for the supply of the village, some farms on the high ground and the part supply of Quenington. At Hatherop a borehole was made and an abundance of water obtained from the Great Oolite for the supply of the village and part supply of Quenington. At Fairford, by the Old Mill, a strong spring issues from the Cornbrash, from which it is thrown out by the Forest Marble. It is used for the supply of a part of Fairford: other parts of this little country-town are dependent on wells, the water-level in many of which is said to rise and fall in accord with that of the river. Between Fairford and the Thames are locally deposits of gravel and it is from two 2-inch boreholes, 20 ft. deep, in the gravel that Lechlade derives its supply.

Sub-basins of the Ampney and Marston Brooks.—The Ampney Brook is generally regarded as having its source in the well-known Ampney Springs in Ampney Park, and for the greater part of the year this view is correct. The source of the Ampney Brook, however, is comparable with that of the Thames near Kemble (see p. 36). For the greater part of the year both sources are at or near where the top-beds of the Great Oolite dip down and disappear beneath the succeeding but lower-lying Forest Marble. But when the water-table in the Great Oolite rises the sources move higher up the valleys—in the case of the source of the Ampney Brook *much* higher up.

A valley may be followed above the Ampney Springs *via* Winterwell Bottom and Calmsden until it dies out in a depression in the upland near Chedworth Laines. For the greater part of the year this valley is streamless down to the bridge that carries the Akeman Street over the brook course a little over half a mile north of Ampney Park. The overflow from the Calmsden spring runs down the valley side and sinks in at the bottom into the permeable Great Oolite.

On the far (east) side of the Fosse Way the main valley is joined by a tributary valley, which—like the main one—originates in a mere depression in the upland, but near Pinkwell. (A well at Pinkwell in the Great Oolite is 47 ft. deep, and in September, 1922, had 28 ft. of water in it; but the well frequently 'goes dry' in the summer and rapidly fills up after rain, when the water is brown with surface matter.)

The neighbourhood of the junction of the valley from Pinkwell and of certain others with the main valley is called 'Winterwell Bottom.' In summer water is usually standing low down in the pond; is reached in a well fitted with a pump at the pump-house; and at 4½ ft. down in an 8½ ft. open well near the wall lower down. Yet lower down is another well, 17½ ft. deep, with water at 4 ft. below the surface.

Thence the valley continues dry usually down to the Akeman Street bridge. Below, more and more water rises, culminating in the Ampney Springs, which Etheridge estimated to flow at 10 to 12 million gallons per day.[1]

In winter-time the water-table in the Great Oolite rises. Water comes down the main valley to Winterwell; Winterwell flows copiously[2] (Etheridge stated[3] that it was capable of delivering 3,000,000 gallons per day); other springs break out near the pond, above the pump-house and elsewhere; the valley bottom is flooded; the pond lost to sight beneath the water, and a powerful stream flows swiftly down the valley through the openings in the walls, and links up with that ordinarily rising on the outskirts of Ampney Park.[4]

At Down Ampney the Ampney Brook is joined by what is called locally the 'County Brook,' which rises near Barnsley, drains a considerable tract of Forest Marble land and receives the waters of the useful spring at the pond in the dip by the side of the Cirencester-Fairford road in Poulton village.

The Marston Brook has a basin area of 17¼ square miles and drains a Forest Marble tract in which is an inlier of Great Oolite. No doubt, surface-drainage is lost to the brook by the sinking in of water into this Great Oolite.

Sub-basin of the Churn.—The River Churn rises at the Seven Springs, which are locally regarded as the source of the Thames, and discharges into the Thames near Cricklade. The area of its basin (including the basins of its tributaries) is 55 square miles, of which 2 square miles are in Wiltshire.

From the Seven Springs to a little below Colesborne the Churn flows for the most part over impervious Upper Lias clay; thence to Rendcombe over permeable Sands; from Rendcombe to half a mile south of North Cerney bridge over permeable Inferior Oolite; and thence to Baunton over impervious Fullers' Earth. During its journey over the sands and limestones the river loses much water by soakage thereinto. Gaugings taken in 1859 by James Simpson showed that whereas the flow of the river where it left the Upper Lias a little to the south of Colesborne was 2,880,000 gallons per day, half a mile to the south of North Cerney bridge—after it had traversed the outcrops of the Sands and Inferior Oolite—its flow was only 405,000 gallons a day: water to approximately the amount of the difference had sunk into the receptive sands and limestones. When the sands and limestones are not waterlogged to the level of the valley-bottom water may be seen locally disappearing down 'swilly holes' situate in the bed of the river; on the other hand when these rocks are water-logged and the water-table rises above the level of the floor of the valley water may be seen rising up through the 'swilly holes.' An opinion once widely held was that the water that

[1] *Proc. Cotteswold Nat. F. C.*, vol. xi, 1893, p. 60.

[2] See Bravender, J., *Proc. Cotteswold Nat. F. C.*, vol. iv, 1867, pp. 247-248, and *Rep. Royal Comm. Water Supply*, 1869, *Minutes of Evidence*, p. 423.

[3] *Proc. Cotteswold Nat. F. C.*, vol. xi, 1893, p. 60.

[4] For a detailed description of the Ampney Brook Valley see Richardson, L., 'Winterwell,' *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 3 for 1923 (1924), pp. 219-222, and pls. xi and xii. See also *Proc. Geol. Assoc.*, vol. xxxvi, 1925, pp. 83, 84.

disappeared down the 'swilly hole' near North Cerney bridge emerged at the Boxwell Springs at South Cerney, but I am of opinion that the Boxwell Springs are the product of the drainage of a Cornbrash tract resting on Forest Marble (see also p. 155).

Robert Anderson once informed me that he recollected accompanying his father when he went to investigate in the interest of the flour mill at The Barton the loss of water to the river by its sinking through the permeable river bed: 'At that time I understood the millers used to go up stream as far as Rendcombe to repair leaks in the side and bed of the river. I have also been told that teams of working bullocks, then used for farm-work, were driven up and down the streams—and more particularly the mill-ponds, which, being artificial, were less sound than the river—to consolidate the bed.'

The river also loses water during its traverse of the Great Oolite between Baunton and (near) Stratton. The bulk of the water in the gravel-bed under Cirencester is derived from the river.

Both J. Bravender[1] and J. H. Taunton[2] have investigated the loss of water to the Churn by its sinking into the permeable rocks.

Between the Boxwell Springs and Cerney Wick water-courses run in all directions and overflow their banks rapidly in wet weather.

CANALS

Six canals have been constructed in the county, namely:—1. Gloucester and Berkeley Canal; 2. Stroudwater Canal; 3. Kennet and Avon Canal (part); 4. Thames and Severn Canal (part); 5. Hereford and Gloucester Canal (part); 6. Coombe Hill Canal.

The first three are in use; the fourth is open only as far as Whitehall Bridge at Frampton Mansell in the parish of Bisley-with-Lypiatt; the fifth (Acts 31 Geo. III. c. 89. 1791; 33 Geo. III. c. 119. 1793) is for the most part filled up and in places followed by the Gloucester-Ledbury Railway (G.W.R.); and the sixth, a very short canal from the Severn near Wainlode to Coombe Hill between Gloucester and Tewkesbury, has long been abandoned.

Gloucester and Berkeley Canal.—This canal, commonly known as the 'Ship Canal,' is 16 miles 6 furlongs in length; it commences at Gloucester by junction with the River Severn and ends at Sharpness, crossing the older (1776) Stroudwater Canal at 'The Junction,' 8 miles below Gloucester.

The water-supply for the canal is obtained principally from the River Frome; to a less extent from the River Cam; while, in dry seasons, these supplies are supplemented by pumping from the Severn at Gloucester.

The Frome is impounded to the necessary height by a weir across it at Whitminster. The surplus water from the Frome is taken under the canal by two large culverts each 10 ft. in diameter. There are also a large number of other culverts of various sizes to take the waters of streams, below the level of the canal on the east side, under it to the west side.

The supplementary supply from the Severn is drawn from just above Llanthony Weir and is delivered into the canal at Gloucester Docks by two large centrifugal pumping engines capable of delivering 285 tons of water per minute.[3]

Stroudwater Canal.—This canal commences at Wallbridge, Stroud, by a junction with the Thames and Severn Canal and ends at Framilode, where it joins the Severn. One mile above Framilode it crosses, on a level at 'The Junction,' the Gloucester and Berkeley Canal. Total length, 8 miles.

Kennet and Avon Canal.—This canal junctions with the Avon at the back of the Great Western Railway Station at Bath. The Avon between here and

[1] *Proc. Cotteswold Nat. F. C.*, vol. iv, 1867, p. 246; *Rep. Royal Comm. Water Supply*, 1869, *Minutes of Evidence*, pp. 422, 423, *Appendix H*, p. 42.
[2] *Proc. Cotteswold Nat. F. C.*, vol. ix, 1886, p. 59.
[3] Cullis, A. J., *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2, 1913, p. 172.

Hanham was canalized in 1727 and the locks along this part of the river are Hanham, Keynsham, Swinford, Kelston, Saltford, and two at Weston or Twerton. These locks and weirs pound the water up to the next weir, which is known as the 'Poulteney Weir.' From the water impounded by this weir access is obtained to the Kennet and Avon Canal proper.

Thames and Severn Canal.—This canal commenced at Wallbridge, Stroud, where it effected a junction with the Stroudwater Canal, and ended at the Round House, Inglesham. ¾ mile S.W. of Lechlade, where it effected a junction with the Thames, close to where the Coln enters the river. The total length of the canal was 28 miles 6 furlongs, and it passed through the Sapperton Tunnel, which is 2 miles 1 furlong long. A branch, 1 mile 3 furlongs in length, ran from Siddington to Cirencester. An excellent account of it, and particularly of the Sapperton Tunnel, has been given by J. H. Taunton.[1]

E. T. Gardom, Clerk to the County Council for Gloucestershire, informs me that on the 30th June, 1900, the Board of Trade issued a Warrant authorising the abandonment of the Canal, upon the condition that the Canal, with all the powers relating thereto, should be transferred to the County Council, and in 1901 the Board of Trade made an Order in pursuance of Section 45 of the Railway and Canal Traffic Act, 1888, for the transfer of the Canal to the County Council, and this Order was confirmed by the Thames and Severn Canal Order Confirmation Act, passed on the 2nd July, 1901. The County Council applied on the 3rd November, 1924, for the abandonment of the whole of the Canal. The application was subsequently amended to apply to the portion which extends from its commencement at or near Lechlade, up to, but exclusive of, Whitehall Bridge at Frampton Mansell in the parish of Bisley-with-Lypiatt, and the Warrant for Abandonment (as to the upper portion: the application as to the lower portion of the Canal being postponed), was given on the 31st January, 1927. On 10th May, 1927, the Ministry of Transport issued an Order releasing the County Council from all liability to maintain the portion of the Canal so abandoned, and from all obligations arising under the several Canal Acts. The Canal is open as far as Whitehall Bridge, but there is not sufficient water for navigation beyond the Bell Lock, Chalford. At present the Stroudwater Navigation Company collect a sum of £550 towards the maintenance of this portion.

HOLY WELLS

There are probably many Holy Wells in the county, about which, however, the literature amounts to practically nothing.[2]

The Rev. Canon Bazeley wrote me (*in litt.* 11th Oct., 1922):—"Whilst the conquerors of the Severn Valley in 577 remained heathen their god Woden or Odin was the patron saint of wells. On the conversion of the Hwiccas to Christianity the mission priests, who found it impossible to change the superstitious customs of their converts, often gave the wells a guardian saint. The healing well near Berkeley escaped the change, and is still called Wanswell or Woden's Well, but many were handed over to St. Anne.

"Of Holy Wells in Gloucestershire I know of Wishanger, near Miserden (which suggests the cult of Woden there), Shepscombe, Hempsted and Wanswell near Berkeley."

In addition, there is Chad Well, Twyning; St. Kenelm's Well, Winchcomb; St. Edward's Well, Stow-on-the-Wold; Holy Well, Chedworth; Oak Well, St. Mary's Well, Boxwell, Down Ampney; Holywell, Wotton-under-Edge; Hempsted, Holy Well, Blaisdon; St. Anthony's Well, East Dean; and St. Aldhelm's Well, Pucklechurch.

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[1] *Proc. Cotteswold Nat. F. C.*, vol. v, 1870, pp. 255-270.

[2] Since this was written there has appeared an exhaustive account of "The Ancient Wells, Springs and Holy Wells of Gloucestershire" by R. C. Skyring Walters, Bristol, 1928.

II.—RURAL DISTRICT SUPPLIES

In the following pages the map references after the place name are distinguished thus :—numbers unenclosed refer to the one-inch New Series maps ; those in square brackets to the Old Series Geological one-inch maps ; those in curved brackets to the six-inch maps.

Abinghall—Maps : 233, 234 ; [43 S.E.] ; (23 S.E., 31 N.E.)

There are only 45 houses in the parish, which is an agricultural one, dependent on wells except for (1) Abinghall Farm, which has water issuing from the Old Red Sandstone forced to it by a ram ; (2) houses along one side (the other side being in East Dean parish) of the Jubilee Road, which are served by standposts supplied from a spring and small reservoir in East Dean parish ; and (3) a few houses adjoining Mitcheldean, which obtain water from the Mitcheldean Water Co., Ltd. A well belonging to the East Dean Rural District Council close to the Lamb Inn (adjoining Mitcheldean) is 37 ft. deep (in Old Red Sandstone) ; it is said not to run dry during the summer, but often to fail in November : indeed, this part of the parish, in itself, is not too well off for water.

Acton Turville—Maps : 151, 265 ; [35] ; (70 S.W.)

The village is supplied by the West Gloucestershire Water Company.

Adlestrop—Maps : 217, 218 ; [44] ; (22 N.E., S.E.)

The village is supplied by an undertaking provided by Lord Leigh. The source of supply is a spring in the Park issuing from the base of the Oolite. There is a reservoir (1,620 gallons) from which the water gravitates to standposts in the village. The yield is constant and the daily average supply is 7,500 gallons.

Admington—Maps : 200 ; [54 S.E., 44] ; (4 S.W., 8 N.W.)

The public supply is provided by the Chipping Campden Rural District Council. The source of supply is springs issuing from the Middle Lias at Lark Stoke, on the northern slopes of Ebrington Hill. The water is conveyed to a reservoir (5,000 gallons) a mile south of Admington Hall, from which it is piped to standposts down the village. The water contains some iron, but has no action on lead.

Houses too far distant for the inhabitants to make use of the standposts are dependent on shallow wells in which there is some scarcity of water during dry seasons.

Alderley—Maps : 251 ; [35] ; (64 N.E., 65 N.W.)

The village is provided for by the Alderley Private Subscription Supply, which obtains its water from a spring at Monk's Mill. The water is piped to a tank (11,000 gallons) at Alderley.

Alderton—Maps : 217 ; [44] ; (13 S.W., 20 N.W.)

The village owes its site to the presence of a superficial sand-bed resting on Lower Lias and is dependent on dry-steined wells. The wells vary in depth up to 15 ft. (Village Well, 10 to 12 ft.) and the rest-level of the water is normally 5 to 6 ft. below the level of the ground. The sand-bed is full of water ; the water is good and has not been known to fail, but unfortunately

the well-waters are liable to surface pollution, a defect which could be remedied in many cases. In 1920, borings, 20 to 30 ft. deep, were made in search of water in the field on the north side of the road immediately east of the School, but without success.

Alderton and Gretton Fields are supplied from wells in the Lower Lias, but the supply is insufficient.

A pool in a field on the Lower Lias clay near Lower Stanley Farm is called the "Salt-water Pool," and the field in which it is situate the "Salt-water Ground." The cattle are very fond of this water. Dixton Manor is supplied from a spring issuing from at or near the junction of the Lower Lias clays and the Sandy Beds of the Middle Lias on the south side of Dixton Hill. The water is piped to a tank by the road-side, whence it gravitates to the house.

Aldsworth—Maps: 235; [44]; (36 S.E., 37 S.W., 44 N.E., 45 N.W., S.W.)

Aldsworth village, apart from Church Farm and cottages belonging to Christ Church College, Oxford, which have water from the River Leach forced to them by rams[1] situate 1 mile S.W. by W. of the Church, were dependent on wells 6 to 30 ft. deep (which were not productive of a satisfactory supply) until 1920. The chief well was a dip well, now covered in with a pump over it, near the War Memorial. There is a useful spring by the stream-side in the dip between the School and the Church. In 1919-1920 Lord Sherborne had water laid on to his property in the village from the reservoir at Camp Farm, near Windrush Camp, in Windrush parish, which in turn is supplied from the Windrush Mill Spring on the banks of the River Windrush (p. 174). Cocklebarrow and Conygree Farm are supplied by gravitation from a reservoir at the top of Lodge Park House, which is fed by water from the Arnold Springs in Sally Coppice, Lodge Park (thrown out by the Fullers' Earth) that is pumped up by a ram in the park.[2]

The springs at Aldsworth and in the valley to the north up to Woeful Lake Farm are probably thrown out by one or more marly beds in the Great Oolite.

The dry ground of the parish on the Great Oolite is very sparsely inhabited.

Alkington—Maps: 251; [35]; (48 S.W., 55 N.E., 56 N.W., S.W.)

The parish is entirely dependent on wells, more or less shallow, the water in which is adequate in quantity and satisfactory as regards quality. The water from the wells in the Lower Lias, however, is very hard.

Almondsbury—Maps: 250, 264; [35]; (62 S.E., 67 N.E., S.E., 68 N.W., N.E., S.W.)

This parish is 7,009 acres in extent. Almondsbury village and parts of Pilning, Easter Compton and Over, Hempton and Patchway, are served by the West Gloucestershire Water Company: otherwise the parish is dependent on wells.

W. Mereweather, in a letter dated 1st May, 1893, to Sir W. F. Barrett, wrote that in 1890 a well was sunk to the depth of about 30 ft. in the blue [Lower] Lias formation. The water rises to within 8 feet of the surface; it is pumped to a brick reservoir on the hill and from this reservoir flows by gravitation to the stand-pipe and houses in the locality.

In the same letter it was also stated that in 1891 a well was sunk at a new house in the parish of Over, adjoining Almondsbury; the well was 44 ft. deep, and the borehole 50 ft., and a very good household supply was obtained.

F. W. Davies, Sanitary Inspector, informs me that the present hospital at Almondsbury is supplied by the West Gloucestershire Water Company.

[1] Marked on the six-inch map, Sheet 44 N.E.

[2] Marked "Pumping House" on the six-inch map, Sheet 44 N.E.

Alstone—Maps: 217; [44]; (13 S.W.)

The village is situate for the most part on a sand-bed that rests on the Lower Lias. The only public supply is the Village Well, which is fitted with a pump, situate by the roadside opposite Middle Farm and said to be about 10 ft. deep. It is fed with water draining out of the sand-bed in the orchard above it.

This well supplies the drinking-water for the village (analysis, p. 244). and there are a few other wells which supply water for other than potable purposes.

Manor Farm has a private supply obtained from springs issuing from at or near the junction of the Lower Lias and Sandy Beds of the Middle Lias, in the hollow to the north of Dixton Wood. In this hollow there has been some slipping of Middle Lias Sandy Beds on to the top-beds of the Lower Lias and the water is collected in catch-wells in the lower portion of the slipped mass. The water gravitates to a small service reservoir which supplies the house.

Alstone Fields Farm is supplied with water from a sand-bed (on Lower Lias) on "Sexty's Grounds" between Bengrove and the Tewkesbury-Stow Road (analysis, p. 244).

Alveston—Maps: 250, 251; [35]; (63 N.E., S.E., S.W., 68 N.W., N.E.)

Parts of the parish are served by the West Gloucestershire Water Company; the remainder by wells (analysis, p. 244). At Itchington rainwater and water from a dipping-place (a small spring) are used.

Alvington—Maps: 233, 250; [35]; (46 N.E., S.E., 47 N.W., S.W.)

The public supply (Alvington Parish Council) is obtained from the Cone Brook at Beanhills—a little above Rowley Mills. The water is filtered and forced up by ram to a reservoir (5,500 gallons) at Duncastle Farm, from which it gravitates to standposts in the village. The supply is constant and the daily average quantity supplied is 1,800 gallons.

Ampney Crucis—Maps: 235; [34]; (43 S.E., 51 N.E., S.E., 52 N.W., S.W., 60 N.W.)

The yield of the Ampney Springs is dependent on the altitude of the water-table in the Great Oolite; in the drought of 1921 the yield was more than halved. W. Pole stated that on 18th March, 1868, their yield was between 5 and 10 millions of gallons[1]: J. Bravender, that in April, 1866, the flow near the mill was considerably more than 20 million gallons in the day; one measurement showing upwards of 30 million gallons[2] (see also p. 41).

An undertaking owned by Major Cripps supplies part of the village of Ampney Crucis. Water is pumped from the springs in the Park to a reservoir (10,000 gallons) also in the Park, from which it gravitates to three public standposts in the village, and also to Glebe Farm near the Barnsley road. Park Farm is supplied from a spring, from which the water gravitates. Hillcott End is served by wells, in the Forest Marble, 12 to 15 ft. deep.

E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, informs me that there is a never-failing spring in the Ampney Knowle valley. The water is raised by a wind-pump to a tank from whence it gravitates to the house and farm. There is also a strong spring at Ampney Riding. Both springs issue from Forest Marble. Sheephouse Farm is supplied from Baunton (see p. 54); but rain-water is also stored underground and raised by hand-pump.

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[1] *Rep. Royal Comm. Water Supply*, 1869, Appendix O, p. 68.
[2] *Ibid*, p. 30.

Ampney St. Mary—Maps: 235, 252; [34]; (52 N.W., S.W.)

The principal sources of supply are shallow wells in the Forest Marble; but in the Lower Field Lane, E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, informs me, is a well and borehole from which "water is pumped to a 5,000 gallon tank and gravitates through a one-inch pipe to Ashbrook and part of Lower Field Farm (Gloucestershire County Council Small Holdings Committee); also to one farm-house at Ashbrook and a public tap. The strata to 56 ft. is clay and Forest Marble: there is a borehole from here to 160 ft., but no greater yield of water was obtained by sinking the latter. This well can easily be pumped dry in a dry season."

Doubtless below the 56 ft. the borehole is in Great Oolite in which the rest-level of the water fluctuates according to the rise and fall of the water-table.

Ampney St. Peter—Maps: 235, 252; [34]; (52 S.W.)

The water supply of Ampney St. Peter village, which is on the Forest Marble, is derived from wells of various depths. E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, has supplied me with the following particulars concerning some of them:—

"*Eastington House.*—Six-inch borehole, about 140 ft. deep, lined with steel tubes. Bottom of clay-bed [of Forest Marble] was reached at 92 ft. ex surface: the 49 ft. below was through stone [Great Oolite]. Water rises to within 26 ft. of the surface and has not been known to fail.

"*Iveson House.*—North of Eastington House. Well [in Forest Marble] about 50 ft. deep. There are two wells near, which are not very deep.

"*Can Court Farm.*—Well 20 ft. deep. Never known to fail.

"*Cottages, London Road.*—Well, 10 ft. deep; 6 ft. of water on 8th June, 1922. This well kept three cottages well supplied during the drought of 1921. There is a similar well at the adjoining cottage and a public one in School Lane. There are a good many weak underground springs near the village pool. All the above wells are in the village and the people suffered very little during the drought of 1921."

Arlingham—Maps: 234; [43 S.E.]; (32 S.W., 40 N.W., N.E.)

The village, which is partly on Lower Lias and partly on gravel resting on the Lower Lias, and parish are dependent on wells from 14 to 25 ft. deep. The supply is adequate and the quality satisfactory. There are no springs worth mentioning in the parish.

Ashchurch—Maps: 216, 217; [44]; (12 N.W., N.E., S.W., S.E.; 19 N.W., N.E.)

This parish is on Lower Lias on the surface of which are in a few places deposits of gravel. The actual village around the Church is on Lower Lias clay.

Ashchurch Station obtains its water in bulk from the Cheltenham Corporation Waterworks, which also supply the area around the Station, Aston Cross, Aston-on-Carrant, Fiddington, Pamington, Claydon and Natton. Houses not so supplied are mostly dependent on wells; but some on surface-water 'springs' and rain-water storage.

A well at one of the cottages at Aston Cross called 'Isabel's Elm' on the one-inch geol. map, Sheet 44, and Aston Cross on the new one-inch map, Sheet 216, was sunk in the Oxynotum Beds of the Lower Lias.

Walton Spa.[1]—Situated near the village of Walton Cardiff (near Tewkesbury), but in the parish of Ashchurch.

For some years previous to 1746 it was known locally that wells in the Lower Lias near where Walton House now stands yielded medicinal waters. In 1787 Dr. James Johnstone, a physician at the Worcester Infirmary, published a booklet on the waters and described, so far as the knowledge of the times permitted, their ingredients. The waters much resembled the saline waters of Cheltenham. A second edition of the Doctor's treatise appeared in 1790, as an appendix to Dyde's 'History and Antiquities of Tewkesbury.' A publicity campaign was then carried out, and Walton House was erected to serve as a hotel for those taking the waters. Walton House was for a time called 'Walton Spa,' but was never put to the use for which it was intended.

A few years previous to 1850 a well was sunk 40 ft. deep in the Lower Lias on the north side of the Tewkesbury-Ashchurch road opposite the drive to Walton House. Similar saline water to that in the original well was encountered and a Pump Room was erected, which still stands. The well is at the back of the building, in the orchard. The scheme, however, was not carried out: those interested in the development of Cheltenham as a Spa arranged terms by which the Walton scheme should not be proceeded with.

Ashleworth—Maps: 216; [43 N.E., S.E.]; (18 S.W., S.E., 25 N.W.)

There are some 90 houses in the parish, which is for the most part on Lower Lias, all dependent on wells, the majority, such as those at Ashleworth Green and Napend, from 20 to 25 ft. deep. Some, however, are deeper, as, for example, those at the Rectory (50 ft.) and 'Foscombe' (40 ft.) (analysis, p. 245), which are on higher ground than the main part of the village.

R. C. Riches, Sanitary Inspector, Gloucester Rural District Council, informs me that there is a spring in Wickridge Street, known as 'The Stream,' running to waste, and another about ¾ mile north-west by west of the church, practically all the water of which runs to waste.

Ashton-under-Hill—Maps: 200, 217; [44]; (6 S.W., 13 N.W.)

The village is situate on the Lower Lias and is supplied with water by an undertaking provided and maintained by the Pebworth Rural District Council. The source of supply is a spring, apparently issuing from the Sandy Beds of the Middle Lias in proximity to the fault-line at Paris, distant a ¼ mile west by south from the church (analysis, p. 245). The water is stored in a covered reservoir (20,000 gallons) at Paris, and conveyed in cast-iron pipes to stand-posts in the village. There is no filtration; the temporary hardness of the water is 20·7°, permanent hardness, 8·4°; the water has no plumbo-solvent action, and the supply has proved adequate except in very dry seasons.

A number of other springs break out from the same geological horizon at Paris and between it and the church. One breaks out in a garden and is collected in a chamber at the eastern corner, distant some 250 yds. due west from the church. This supplies Walnut Tree Farm and the overflow goes into a streamlet.

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[1] See—

1787. Johnstone, Dr. James.—Some Account of the Walton Water near Tewkesbury, 8vo, Worcester.

1790. ——————————.—Some Account of the Medicinal Water near Tewkesbury, 2nd ed. Printed as an Appendix to Dyde's History and Antiquities of Tewkesbury.

1830. Bennett, James.—'The History of Tewkesbury,' p. 12 (footnote).

1839. Murchison R. J. 'Silurian System,' 4to, London, 1839, p. 35.

1850. 'The Tewkesbury Yearly Register and Magazine,' vol. ii, pp. 457-458.

1927. Richardson, L.—'Walton Spa,' near Tewkesbury. *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 3 for 1926, pp. 259-260, pl. xxix (lower fig.).

A spring issuing near the preceding is piped to a chamber (marked 'W' on the six-inch map, 6 S.W.) about half-way between the church and Paris. It supplies Manor Farm and taps serving a number of cottages.

Another spring maintains a stream that feeds the pond south-west of the church.

Aston Blank—Maps: 217, 235; [44]; (28 S.E., 36 N.E.)

The village of Aston Blank or Cold Aston is situate at the end of a promontory of the basement beds of the Great Oolite Series just above the Fullers' Earth. It is supplied from several sources. About ¼ mile north-west of the church, between it and Folly Farm, a good spring is thrown out by the Fullers' Earth in a field called 'Whitefurlong.' There is an intake chamber at the spring-head and two rams in the field below which pump the water to a reservoir on a water-tower near the church. Water from this water-tower supplies Grove and Dryground Farms and fields, and a trough in Grove Farm yard from which a number of cottagers in the vicinity fetch their drinking-water as their well-waters are unsuitable for such purpose. There are useful overflows from the intake chamber and the tail-race of the rams, which run to waste into a streamlet that originates near Folly Farm and flows down the valley to Broadwater, losing much of its water, by percolation into the Inferior Oolite, on the way.

The wells in the village are from 20 to 30 ft. deep. There is a 'Parish Pump' in the middle part of the village, and a 'Parish Well,' a spring thrown out by the Fullers' Earth and caught in a well with a lid, at the southern end.

Aston Farm and fields are supplied with spring-water issuing from the base of the Cotteswold Sands, on the south bank of the Windrush. The water is pumped up by a water-wheel.

At Gilbert's Grave alongside the Fosse Way the well, in Inferior Oolite, at the cottage is 78 ft. deep. On 3rd August, 1925, it was dry; it rarely has more than from 5 to 6 ft. of water in it.

Some 40 to 50 years ago, I was informed locally, it was the full-time occupation of three men in the village to puddle dew ponds, their work taking them over a large district.

Aston Somerville—Maps: 200, 217; [44]; (6 S.E., 13 N.E.)

The water-supply of the village is obtained from the Evesham and Pebworth Joint Water Committee.

Aston Subedge—Maps; 200; [44]; (7 N.E., S.E.)

The village is on the Lower Lias and is supplied by a private undertaking belonging to the Earl of Harrowby. The source of supply consists of springs issuing from at or near the base of the Sandy Beds of the Middle Lias up the hollow south-east of Aston Subedge School and immediately to the south of the Aston-Subedge-Chipping Campden road. The ground is very wet in the neighbourhood of the 400-ft. contour-line in this and the next hollow to the south-west, and in both some of the spring-waters make an irony deposit. There are a number of collecting chambers and the daily average quantity of water supplied is 5,660 gallons. The supply is constant.

Aust—Maps: 250; [35]; (62 N.E., S.E.)

The parish is dependent on wells. Near the church is a small spring feeding a dip well.

Avening—Maps: 234, 251; [34]; (49 S.E., 50 S.W., S.E., 57 N.E., 58 N.W.)

The Cherington Springs and the River Avon (or 'Aven,' as local people prefer to spell it) are said to have been diminished in volume by pumping at the waterworks of the Stroud Water Company in the Frome Valley (p. 120). The Cherington Springs and those above Avening, however, are fed with water

that has percolated through the Great Oolite and been thrown out by the Fullers' Earth; while the Stroud Water Company's wells tap water in the Cotteswold Sands. In spite of heavy rains it is a fact, however, that the course of the Avon through Avening was dry on Aug. 19th, 1922.

Strong springs issue from the Cotteswold Sands which crop out in the south side of the Avon valley between Longfords and Iron Mills. The spring seen in the stone-sided opening in the road in front of the west face of Longfords Mills comes out of the bank to the south, and is said to have appeared when Longfords Mills' pond (Gatcombe Water) was made (in 1806) by the impounding or 'stanking back' of the Avon and water worked round the dam through the Cotteswold Sands. Pumping 300 gallons per minute had no effect on the supply.[1] The water of Gatcombe Water drives the turbine which supplies most of the power for Longfords Mills. Another strong spring issues from the Sands some 60 yds. to the west of the preceding and flows along a water course that discharges into the 'canal' that feeds the Iron Mills mill-pond.

There are a few wells in use in Avening; but there is a public supply from standposts. The undertaking is the property of the Parish Council. The source of supply is a spring thrown out by the Fullers' Earth in a field called 'Woodcrops,' at Longmans. The water is collected into a tank close to the spring, from which it gravitates to the standposts. Forty Acres, a new house at the top of Tetbury Hill, has water pumped to it by a ram from a spring (thrown out by the Fullers' Earth) at Oldfield in Ledgemore Bottom.

Aston Farm is supplied (private supply—Chavenage Estate) from springs (Cherington Springs) thrown out by the Fullers' Earth in Gillhays Bottom, above the northern extremity of Cherington Lake.[2] The water is conveyed to tanks from which it is forced up by a ram to a reservoir at Dunkerspool, whence it supplies Aston Farm, Dunkerspool and Field Barn. The Stroud Water Company's water is being laid on to Lowsmoor Farm; it was piped to the Minchinhampton Aerodrome (disused) during the War.

Aylburton—Maps: 233, 250; [35]; (46 N.E., 47 N.W., S.W., 55 N.W.)

The village is on the Old Red Sandstone and is supplied by the Aylburton Water Supply Committee, whose source of supply is a spring coming out of the Carboniferous Limestone at Berryfields, Lodge Lane. There is no reservoir: the water is laid on to the houses supplied from this source, and the supply is abundant and constant. Aylburton Common is supplied with compensation water from the Lydney mains.

Badgeworth—Maps: 216, 234; [44]; (26 S.W., N.W., S.E.; 34 N.W., N.E.)

By far the greater part of this large parish is on the Lower Lias on the surface of which are locally deposits of sand and gravel.

The parish is supplied by the Gloucester and Cheltenham Waterworks, an undertaking of the Cheltenham Rural District Council, wells and springs. Badgeworth Court and the Manor House are connected with the mains of the Gloucester Waterworks. Cheltenham Corporation water is laid on to The Reddings.

The Cheltenham Rural District Council's undertaking supplies most of the village. The source of supply is water collected by agricultural drain-pipes from a gravel-bed resting on Lower Lias clay in the field immediately to the east of Houlbrooks Cottages, two-thirds of a mile S.E. by E. of Badgeworth Church. The water is conveyed by a pipe to a tank (1,200 gallons) at Badgeworth Cross. The only house having a piped supply from the tank is the Vicarage. The supply of water has never been known to fail, although the supply was rather limited in the dry period of 1921. The hardness of this water is 9°.

Proc. Cotteswold Nat. F. C., vol. xxi, pt. 3 for 1923 (1924), p. 191.

[1] *Idem*, pp. 192-194.

A. J. Stephens, formerly of Badgeworth Court, has furnished me with the following particulars of wells, all in the Lower Lias with the exception of that at Badgeworth End, which is in a pocket of gravel in the Lower Lias :—

Site of Well	Depth	Depth to water level	Nature of Supply	Quality
	Ft.	Ft.		
Green Farm	60	12	Very fair	Good
The Manor (previously known as 'The End')	40	8	Good	Not potable
Badgeworth End (on the site of the 'Oak Farm')	30	10	Good	Good
Stanby's Farm, Badgeworth Cross	40	12	Poor	Very fair
Badgeworth Court, No. 1 ...	60	12	Plentiful	Clear and bright but too near churchyard
,, ,, No. 2	32	20	Plentiful	Fair
Brook Farm, No. 1	60	—	Good	Potable
,, No. 2	—	—	Poor	Not potable, used for cattle
Ashley Villa	30	10	Fair	Good
Cottages known as 'The Farm'	40	12	Fair	Poor, not potable
Coldpool Bungalow	18	3	Fair	Good

There are many wells in the Lower Lias at Bamfurlong and The Reddings, the water in which is distinctly saline. Cold Pool contains brackish water.

Mr. Stephens has also communicated the following particulars concerning the water-supplies of Crickley, Bentham and Little Witcomb.

Site	Depth of well	Remarks
Crickley :	Ft.	
The Ferns	14	Fed by spring. Good.
Crickleigh Farm	12	,, ,, ,,
Bentham :		
Bentham Farm	10	Poor. Used for drinking
Manor Farm	10	,, ,, ,,
Little's	—	No water. Drink from brook
The Elms	—	Water piped from spring ½ mile E.S.E. Good and plentiful
Boucher's Farm ...	10	Poor
Little Witcomb :		
Witcomb Court		Tank fed from spring near Crickleigh Farm. Good. Water carried from here to 21, 22, and cottages near
Rosebank	8	Poor. Not used for drinking
Chandler's Farm ...	8	,, ,, ,,
Springfields	—	Tank fed by springs (? issuing from gravel). Good, but hard water

Springs.—In the eastern portion of the parish are numerous springs thrown out by the Upper Lias from the base of the superincumbent Oolite. The majority are small owing to their restricted collecting-grounds. A number appear well below the top of the Upper Lias, and of these some issue from sandy layers in the upper portion of the Upper Lias, some from masses of slipped Oolite and others from hillside gravel. Certain are :

About 800 yds. E. by S. of *The Greenway.* About 470 ft. above O.D. Supplies The Greenway. An additional supply has been recently obtained from an older piped supply that was discovered.

Below *Barrow Piece Plantation.* About 730 ft. Small spring.

Dryhill. About 605 ft. Supplies Dryhill Farm. A very good spring running practically to waste which at one time was considered as a contributory source of supply for Gloucester. Gauged by J. H. Taunton, March 1854, 115,200 gallons per day ; and by D. J. Humphris in Aug. and Sept., 1864, 9,429 gallons per day (*House of Lords Sel. Com. Chelt. Water Bill. App. to Min. Evidence,* 1st June 1865, p. 143).

At ⅓ mile W.S.W. of *Air Balloon Inn.* 631·8 ft. Very constant and supplies whole neighbourhood, including Birdlip, in periods of drought.

At ⅙ mile W. by S. of *Air Balloon Inn.* 700 ft. Small spring which has not been known to cease flowing.

Barrow Wake or the ' Bell Inn ' Spring. 540 ft. A good spring supplying the fish-tank at Belmont—the old Bell Inn. Etheridge once suggested that the " Bell Stream " should be piped into the Witcombe Reservoir (Report, 13th July, 1891, p. 3). Gauged by J. H. Taunton, March 1854, 130,750 gallons per day ; by D. J. Humphris, Aug. and Sept., 1864, 16,058 gallons per day (*House of Lords Sel. Com. Chelt. Water Bill, App. to Min. Evidence*, 1st June, 1865, p. 143).

Bagendon—Maps : 235 ; [34, 44] ; (43 N.W., S.W., 51 N.W.)

At Dartley Farm the water from a strong perennial spring is collected into a tank and forced up to a cement tank (5,000 gallons), from which it gravitates to the farm, farm-buildings and a cottage. At Stancomb, nearby, is another good spring.

At Price's Barn (*olim* Forty Acres Barn a little over a mile to the south of Bagendon) is the well referred to by Prof. [Sir] W. F. Barrett as " at farm buildings belonging to Mr. J. Hayward."[1] The well is 120 ft. deep, through Great Oolite (? to Fullers' Earth), and E. J. Mathews informs me that " there was a good supply last year [1921], but it was much enfeebled this year. Springs from this source flow towards Trinity Mill, Cheltenham Road."

Perrott's Brook supply is obtained from a spring in the field west of the Cheltenham Road ; water is collected into a trough and overflows to a pipe by the side of the Cheltenham Road. A separate pipe from this trough runs to the Bear Inn and three cottages.

A strong perennial spring to the north-west of Moorwood House gravitates to a tank (600 gallons) from which it is raised by an electric pump to an underground reservoir (17,000 gallons), from which it gravitates to the house and six cottages, five of which are at Woodmancote in North Cerney parish.

All the springs mentioned are thrown out by the Fullers' Earth.

Barnsley—Maps : 235 ; [34] ; (43 S.E., 44 S.W., 51 N.E., 52 N.W.)

This parish is for the most part on Forest Marble but Great Oolite crops out from beneath in Winterwell Bottom.

Apart from the village the parish is very sparsely populated. The village is dependent on wells in the Forest Marble ; but while the water is said to be satisfactory, the quantity is limited and inadequate in dry weather.

[1] *Proc. Soc. Psychical Research,* vol. xiii, 1898, p. 73.

Barnsley Park is supplied from well and borehole, stated to be 160 ft. deep, through Forest Marble into Great Oolite (well, about 100 ft.; borehole, about 60 ft.). The water is raised to a water-tower (about 10,000 gallons), from which it gravitates to the Park and Home Farm.

Poultmoor Farm is supplied by well, about 18 ft. deep, in Forest Marble.

Barnwood—Maps: 234; [44]; (25 S.E., 33 N.E.)

This parish is on Lower Lias on the surface of which, however, locally are considerable deposits of sand and gravel.

Out of 275 houses 75 are supplied with Gloucester Corporation water. Those not so supplied are dependent on wells up to about 10 ft. in depth in the sand and gravel deposit, the water in which is, on the whole, satisfactory as regards quality and quantity.

Batsford—Maps: 217; [44]; (15 N.W., S.W., S.E.)

John Kennedy, sometime agent for the Batsford Estate, informed me that the water supply to the Park and village is obtained from seven springs (held up or thrown out by the Upper Lias clay) collected in the Park and conducted to two reservoirs. The springs are all tapped at from 6 to 9 ft. below the surface of the ground. There are no wells in use for the purpose of supply either to the mansion or village other than the Cold Well Spring (issuing from at or near the base of the Sandy Beds of the Middle Lias) in 'Caudle Meadow' near the lake south of the mansion. Toward the end of the lengthy drought of 1921 nearly all the springs in the Park failed and Cold Well Spring was depended on.

There are no traces of irony water in the Park supply, but these are strongly in evidence in 'Showell's[1] Lane Spring' about a mile distant.

A boring in Batsford Park situated 260 yds. N.W. by N. of Batsford Church was made by Messrs. Le Grand and Sutcliff about 1894, with a view to testing the quality of the clay in the Park. Particulars communicated by the sinkers.

Boring (finishing 1¼ in. diameter):—

[Sands and Upper Lias clay] Marl	57½ ft.

Water-level, 9 ft. below surface. Yield, 330 gallons per hour.

Baunton—Maps: 235; [34]; (43 S.W., S.E., 51 N.W., N.E.)

About ¾ mile north of Baunton, close to the Churn, strong springs, thrown out by the Fullers' Earth, are tapped by wells. These springs were enfeebled during the drought of 1921; but a new well sunk in that year by H. J. Godwin, of Quenington, close to the old ones, obtained an abundant supply of water. The water is raised by a wind-pump, supplemented by an oil engine, to tanks at the following places:—Whiteway Road (500 gallons), The Exhibition Buildings (15,000 gallons), The Sisters (1,000 gallons), Dillies Farm (two: each 500 gallons), Baunton Lane (300 gallons), Downs Farm (100 gallons), Harebushes (reinforced concrete tank, 3,000 gallons), Wiggold (Cirencester Urban District) (1,000 gallons), Norcote Farm, Preston (1,000 gallons), Ampney Sheephouse (Ampney Crucis parish) (500 gallons).

Baunton village and the golf links are supplied from this source.

The average daily quantity of water obtained is about 10,000 gallons; but a practically unlimited quantity remains.

Beckford—Maps: 217; [44]; (6 S.W., 12 N.E., S.E., 13 N.W., S.W.)

This parish is mainly on Lower Lias on the surface of which are locally deposits of sand and gravel.

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[1] "Shoals" on six-inch map.

The houses in Beckford village, which is on sand and gravel, were until 1907 supplied from wells sunk into the superficial sand-bed, which is full of water, but since that year by an undertaking provided by the Winchcomb Rural District Council. The water is obtained from a spring (? issuing from the Sandy Beds of the Middle Lias) in a withy plantation, where there is also a reservoir, on the 400-ft. contour-line to the north of Grafton on Beckford Hill.

The hamlet of Little Beckford, 1 mile S.W. by S. of Beckford, is partly on sand and partly on clay. "Grafton water" (Beckford supply) is laid on to the houses; but some wells are still in use for other than potable purposes. That at 'Fernlea' is 16 ft. 6 in. deep (from top of well-cover) and in May, 1922, had 12 ft. of water in it.

One part of the hamlet of Grafton is served by standposts fed from the Beckford supply; while the other has water piped from the easternmost of three strong springs thrown out by the Upper Lias clay on the 600-ft. contour-line $\frac{1}{6}$ mile N.W. by N. of the withy-plantation spring. There is a considerable surplus of water from this spring, and there are at least two other good springs that issue from the base of the Inferior Oolite at or near the 600-ft. contour line. The westernmost runs through three cattle troughs before coursing down the hill-side, and on May 7th, 1922, was running at least 2,000 gallons per 24 hours.

The little hamlet of Bengrove is supplied by a small but constant spring issuing from at or near the base of the Sandy Beds of the Middle Lias in Bengrove Coppice. The water is collected into a tank whence it is piped to the principal houses of the hamlet.

Berkeley—Maps: 251; [35]; (47 S.E., 48 S.W.)

Berkeley parish is on the Old Red Sandstone.

Berkeley Castle and an increasing number of houses in the town are supplied by a private undertaking installed by Lord Fitzhardinge. The source of supply is the Holy Well at Wanswell, in Hamfallow parish (p. 98), and from the reservoir there the water is piped to Berkeley and pumped to tanks ((*a*) 3,000 gallons, (*b*) 5,000 gallons) at the top of the Castle. Houses not so supplied are dependent on wells 15 to 20 ft. deep.

Beverstone—Maps: 251; [34]; (57 S.E., 65 N.E.)

This parish is on the Forest Marble which contains numerous layers of clay. The village draws its supply from wells, but there is a Parish Pump by the road-side fed with spring water that has been collected and piped thither. T. V. H. Davison, Sanitary Inspector, Tetbury Rural and Urban Councils, informed me that there is plenty of water in and around the village. It is all contained in or issues as springs from the Forest Marble series; but, of course, if the wells were much depeened the subjacent Great Oolite would be entered and the water from the Forest Marble lost.

Well at Beverstone Rectory.—Particulars communicated by C. E. N. Bromehead. Well sunk about 1905.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
[Forest Marble]	1. Soil	4	0	4	0
	2. Yellow limestone	2	0	6	0
	3. Blue clay	0	6	6	6
	4. Blue limestone	2	6	9	0
	5. Blue clay	0	4	9	4
	6. Blue limestone	5	6	14	10

Mr. Bromehead states that this well was sunk on the advice of a dowser. The old well was 21 ft. deep and went dry every summer. The new well was within 15 ft. of the old and the supply has not failed since it was sunk.

"Wells may strike water or be dry a few yards away owing to the lenticular formations of clay and limestone" (C. E. N. B.).

Bibury—Maps: 235; [34, 44]; (44 N.W., S.W., N.E., S.E., 52 N.W.)

This parish is 5,198 acres in area. Patches of Forest Marble cap the high ground; below comes Great Oolite, beneath which is Fullers' Earth exposed in the bottom of the valley of the Coln above Bibury.

Bibury village obtains its water from shallow wells, springs, and the River Coln (partly piped). There is a well in the Square, fitted with a pump, which gives a good supply. The Pumping House at the famous Bibury Springs, near The Swan Hotel, supplies Bibury Court, the Vicarage, Swan Hotel, part of the village, Bibury and Oxhill Farms, Hale Barn; and Kilkenny Farm and Cottages in the Leach Valley.

The Bibury Springs (see p. 41) rise in grounds belonging to The Swan Hotel at about the place where the Fullers' Earth dips down beneath the Great Oolite. The yield of the springs has not been actually gauged recently, but is estimated at a million gallons a day: John Bravender said their discharge was rather more than that of the Ampney Crucis Spring.[1]

Arlington is supplied partly by wells and partly, per pipe, from the Winson Spring (p. 41). There is a draw-well on The Green.

Ablington is supplied from two sources—(1) a privately owned reservoir near the River Coln at the eastern end of the village, the water being raised by a wind-pump, and (2) from a public tap in the village fed from another spring.

A good spring of water is thrown out by the Fullers' Earth below Hollow Pen (382·3 ft. above O.D.) to the north-west of the village, the water from which is pumped to farms. This may be the 'Ablington Spring' of John Bravender, who stated in 1869 that its yield was more than 2 million gallons a day.[2]

Kingsellhill Spring near Downs Farm (about a mile N. by W. from Ablington) is a good spring thrown out by a marly bed in the Great Oolite water from which has since 1928 been pumped to Saltway Barn and Oldwalls Sheds.

Bishop's Cleeve—Maps: 216, 217; [44]; (19 N.E., S.E.)

Most of the houses in the village, which is mainly on a sand-bed resting on Lower Lias, have a piped service from a supply provided by the Winchcomb Rural District Council. The sources of supply are: (*a*) Wickfields Spring, in the field on the west side of the main road to Winchcomb due west of the Convalescent Home, Cleeve Hill, which is derived from the base of the Inferior Oolite, and (*b*) a spring in the grounds of Mount Vernon below Holder's Hill, Woodmancote, which issues from the base of the Sandy Beds of the Middle Lias. This latter supply has been augmented from a spring near by, also issuing from the Middle Lias, the water of which is taken into the pipe from the Mount Vernon source. The former supply (*a*) has a tank at Horses' Green and the latter (*b*) in the Mount Vernon—close to the spring. There are a few wells, some fitted with pumps, still in use, the water from which is said to be satisfactory as the result of analysis.

Cleeve Grange is served by the Rural District Council's supply, but to augment it two large shallow wells have been sunk in the gravel (which rests on Lower Lias clay) and a narrow sump from which the water is raised by a wind-pump to a storage tank. The water in the wells went very low in 1921 and the supply was very small. A stream rises from the gravel-bed near by. The gravel runs irregularly about here and is said to have layers of clay in it. Wells about 10 ft. deep, however, yield a good supply of satisfactory water.

[1] *Rep. Royal Comm. Water Supply*, 1869, p. xxx.
[2] *Ibid*, p. 30.

When the village was sewered the deepest part of the trench was 15 ft., and in sand which was full of water.

Dr. T. Jamieson states that at Cleeve Field, near "Gotherton" (Gotherington) is a spring which yields a weak brine.[1]

Bisley-with-Lypiatt—Maps: 234, 235; [34, 44]; (41 S.E., 42 N.W., S.W., N.E., S.E., 49 N.E., 50 N.W., N.E.)

The village of Bisley, partly on Great Oolite and partly on Fullers' Earth, is supplied by wells and springs, particularly by the Bisley or Seven Springs, which are drawn on largely by the farmers of the neighbourhood as well as by the villagers. The springs were enfeebled in 1921 and the wells ran low (analysis, p. 246). The springs are fed with water that has sunk through the Great Oolite and is thrown out by the Fullers' Earth. They are the source of a tributary of the Toadsmoor Brook, which rises in a spring thrown out by the Fullers' Earth in Blanche's Bank below Stancombe Farm. Lypiatt Park is supplied from a spring thrown out by the Fullers' Earth in the Park, water from which is forced up by rams. Good springs issuing from the same geological horizon are those at Middle Lypiatt, Lower Lypiatt (in Thrupp parish), and below Bussage Churchyard.

Nashend, Eastcombe, Bournes Green, Oakridge, Oakridge Lynch, Tunley, Daneway, Waterlane, Battlescombe, Througham, Slad Farm, Calfway Farm, Stancombe Farm, Fennell's Farm, Lypiatt, Ferris Court and Middle Lypiatt, are all situate either on the basement beds of the Great Oolite or on Fullers' Earth, where water is obtainable from shallow wells or springs. Other springs thrown out by the Fullers' Earth are those at Bournes Green, which is the source of a brook that joins the Frome below Baker's Pool; Oakridge Lynch, which is likewise the source of a small stream; Hill House and Snakeshole, which give rise to a stream that flows down the Horns Valley that is joined by a streamlet rising below the Heavens.

The Slad Brook comes down the Dillay Farm valley and flows below Snow's Farm and Steanbridge Farm, and southwards through the pond at Steanbridge. Below Snow's Farm the Slad Brook is joined by a brook coming down the 'Piedmont Valley.' The brooks derive their supplies from springs issuing from the base of the Cotteswold Sands. F. S. Cutler, Surveyor and Water Engineer to the Stroud Urban District Council, gauged the flow of the brooks on 31st August, 1927 (weather fine):—

	Gallons per 24 hours
'Dillay Farm Brook' (*i.e.*, the Slad Brook above the bridge below Snow's Farm)	319,680
'Piedmont Valley Brook' near its junction with the Slad Brook	172,800
Combined brook (Slad Brook) below in-flow of 'Piedmont Valley Brook'	492,480

The stream at the weir at the outlet of Steanbridge pond on 23rd June, 1927, was flowing at some 600,000 gallons per day.

Analyses, p. 246.

Bitton—Maps: 265; [35, 19]; (76 N.E., S.E., 77 N.W., S.W.)

According to the L.G.B. Return, 1915 (p. 429), 475 out of 752 houses are supplied by the West Gloucestershire Water Company, those not so supplied being dependent on wells and springs, the water of which is said to be generally good and adequate.

Cowhorn Pit.[2]—The old Cowhorn Pit is now one of the sources of supply of the West Gloucestershire Water Company (p. 194).

[1] "A Treatise on Cheltenham Waters," 1814, p. 59.

[2] *Rep. Royal Coal Comm.* H. B. Woodward, 'Geology of East Somerset and the Bristol Coal-Fields' (*Mem. Geol. Surv.*) 1876, p. 39.

	Thickness Ft.
Pennant Grit	18
Millgrit Seam, about 3 ft.	12
Coal Measures	
Rag Seam, about 18 in.	210
Coal Measures	
Buff Seam, about 4 ft.	120
Coal Measures	
Parrot Seam, about 21 in.	24
Coal Measures	
Little or Brimstone Seam	

Boring at the Golden Valley Paper Mills, Bitton (formerly Messrs. Somerville).

Site.—In the midst of Messrs. Somerville's Paper Mills.

Surface-level.—About 50 ft. above O.D.

Made for Messrs. Somerville by Thomas Matthews of Manchester. Commenced November, 1893; finished August, 1894.[1]

Section :—

		Thickness Ft.
Lower Lias clays, shales, and limestone beds, 216 ft.	1.—Surface to level of Pumping floor ...	—
	Made ground, etc.	6½
	2.—Blue clay (Lias)	23½
	3.—Blue shale (Lias)	27
	4.—Grey rock (Lias)	0½
	5.—Blue clay (Lias shale)	23½
	6.—Grey rock (Lias)	1½
	7.—Blue shale (Lias)	21½
	8.—Grey rock (Lias)	1
	9.—Grey bind (Lias shale)...	15
	10.—Grey rock	2
	11.—Blue shale	13
	12.—Blue shale and Grey rock alternate ...	7
	13.—Blue Lias rock. Core 154 and 177 contains traces of fossils and fish scales and are dense and crystalline	42
	14.—Blue Lias and marl alternate	24
	15.—Blue Lias rock	8
Rhaetic 14 ft.	16.—White limestone and White Lias ...	11
	17.—Brown marl (probably White Lias shale)	3
Keuper 184 ft.	18.—Blue marl and limestone (New Red marl)	13
	19.—Red marl (New Red)	18
	20.—Red marl and mixed red rock (variegated marls)	15
	21.—Conglomerate (Gypsum)	17
	22.—Conglomerate and bands of marl (Gypsum)	46
	23.—Conglomerate (Gypsum)	5
	24.—Conglomerate and marl (sandy beds)	4
	25.—Harder conglomerate with calcite (Gypsum)	61
	26.—Pennant Grit	5
	Total	414

[1] Described by the late Rev. H. H. Winwood, *Proc. Bath Nat. Hist, & Antiqu. F. C.*, vol. viii, 1895, pp. 141-146.

From surface level to 84 ft.	the bore has a	diameter of	14 in. and is cased.
84 ft. to 125 ft.	,,	,,	12 in. ,, ,,
125 ft. to 296 ft.	,,	,,	11 in. with cylinder from 214 to 296 ft. only.
296 ft. to 417 ft.	,,	,,	9 in. and is uncased.

Winwood stated that a piece of core labelled '225' was evidently a piece of White Lias (Rhaetic), and a piece numbered '233', a highly pyritic portion of the Rhaetic Bone Bed. The beds described by the sinker as 'Conglomerate' were Keuper Marls with gypsum, and a portion numbered '246' and described as "blue marl and limestone" was ordinary red Keuper marl with a patch of grey. Winwood also stated that, judging by cores in his possession, the Keuper Sandstones appeared to be absent from here and the Keuper Marl to rest directly on the Pennant Grit.

Water, Winwood remarked, was obtained from the gypseous marls of the Keuper, and amounted to some 5,760 gallons per hour. When the pumps were at work the water-level dropped from ground-level to 12 ft. below (analysis, p. 247).

Blaisdon—Maps: 234; [43 S.E.]; (24 S.W., 32 N.W.)

There are no wells in the village of Blaisdon: it is supplied from a spring, issuing apparently from the fault by which the Keuper Marl is let down against the Silurian, which is caught in an underground reservoir at The Lodge to the Hall. From the reservoir the water is piped to standposts down the village.

Near Blaisdon Hall, in Holywell Grove, is a Holy Well in the basement-beds of the Wenlock Limestone.

Boring near Stanley Farm.—Made in 1906 by E. Timmins and Sons, Ltd., of Runcorn, under the instructions of Willcox and Raikes of Birmingham. Surface-level, about 160 ft. above O.D.

	Ft.
Keuper Marl	600
Keuper Sandstone	200

The water was found to be too hard for domestic purposes so is pumped to an open reservoir in Blaisdon Wood, from which it gravitates to The Home, Stanley and Studd Farms for general farm purposes, and to Blaisdon Hall for other than potable purposes.

At Stanley Farm is a well in Keuper Marl, 70 to 80 ft. deep.

Boring at Brickhouse Farm.—Made in 1916. Surface-level, about 200 ft. above O.D.

	Ft.
Keuper Marl	157
? to Sandstone.	

The water is raised by a windpump into a tank and supplies the adjoining fields.

Boring at Velt House.—Made in 1907. Surface level, about 250 ft. above O.D.

	Ft.
Ludlow, Wenlock Limestone	168

J. S. Bate, Agent to the Blaisdon Estate, informs me that the water is raised to concrete tanks at the top of Blaisdon Hill, from which it gravitates to Blaisdon Hall for drinking purposes and also supplies the fields on the Velt House side of the hill.

Bledington—Maps: 217, 218; [44]; (29 N.E.)

The village is served by wells sunk into gravel that rests on Lower Lias. A well 4 ft. deep supplies three or four cottages, but otherwise each house has its own. The wells are from 4 to 6 ft. deep in the lower part of the village and from 26 to 30 ft. deep in the upper part. The supply is in an unsatisfactory condition and there are no potential sources within the parish.

Bledington Ground is supplied by a well 70 ft. deep—through a little gravel into Lower Lias clay. Normally, J. Davison, the tenant, informs me, the depth of water in the well is 50 ft.; but although it fell some 10 to 15 ft. in 1921, owing to the drought, the available supply remained ample.

Boddington—Maps: 216; [44]; (19 S.W., 26 N.W.)

The mains of the Cheltenham Corporation Waterworks run through the parish, which is on Lower Lias, and water is laid on therefrom to Boddington Manor and The Barrow. Houses not so supplied are dependent on wells, from 12 to 18 ft. deep.

A well at Butler's Gate Cottages is about 13 ft. deep, and in June, 1922, the water reached to within 4 ft. of the top.

The well at Haydon Knoll Farm is said to have 'a seam of silver sand,' 3 in. thick, in the Lias clay at a depth of about 10 ft.

The drinking water for Whitehall Farm comes from gravel resting on Lower Lias clay.

Bourton-on-the-Hill—Maps: 217; [44]; (14 S.E., 15 S.W.)

Bourton-on-the-Hill, on the eastward-facing escarpment overlooking the Moreton Valley, is poorly off for water; the escarpment is much covered with slipped rock and such springs as issue are mostly small and shallow-seated. Three springs are thrown out by the Upper Lias clay in the valley of the Dikler eastward of Bourton Hill House: one close to where the road crosses the stream, on August 8th, 1925, equalled in volume that of the stream coming down the valley. It is not used. Springs thrown out by the Upper Lias clay near Hailstone Farm towards the head of Dovedale, Blockley, are used to supply Blockley, Worcestershire (analysis, p. 248).

Slate Barn Boring.—A trial boring for water for Moreton-in-Marsh in the south-eastern angle of the road-bounded triangular area about two-thirds of a mile north-north-east of Bourton Hill House proved:—

		Thickness Ft.
Chipping Norton Limestone (basal portion)	Rock	40
Snowshill Clay	Clay	8
Harford Sands to *Scissum*-Beds (inclusive)	Rock	200
Cotteswold Sands	Sand	

The Snowshill Clay crops out and throws out small springs a third of a mile north-east by east of Bourton Hill House.

Bourton-on-the-Hill village is supplied from 20 to 30 wells, fitted with pumps, a catch-pipe and dip by the road-side at the lower end of the village, a Village Pump at the upper end, and there are three private piped supplies. The Village Pump is over a well, formerly approached by steps, which is fed by a spring.

Bartlett's House, near the top of the village, is supplied by a pipe from a spring, thrown out by the Upper Lias, near the spinney a third of a mile north-north-west of the church. The pipe is continued from the house and ends in the field called 'The Leys.'

The Rectory, cottages near, and house immediately west of the church, have a piped supply from a spring about 150 yds. west of 'Kinson's Well.'

Kinson's Well is maintained by a good spring situate an eighth of a mile south-west by west of the church. The water is piped to Bourton House. One branch from this main runs to the Smithy and on to the house below the Tithe Barn; another branch supplies a tank on the north side of the road just above Bourton House, which feeds the catch-pipe and dip referred to above. This pipe and dip were provided by Lady East some 60 years ago.

On the left bank of the Dikler east of Bourton Hill House several springs are thrown out by the Upper Lias; one, close to the road, is a good one.

Bourton-on-the-Water—Maps: 217, 235; [44]; (28 S.E., 29 S.W., N.W., 36 N.E., 37 N.W.)

There is no public supply: the village is supplied by some 200 wells sunk in gravel (resting on Lower Lias clay), 190 of which are not more than 7 ft. deep, but a few near the station, where the gravel occurs in channels in the Lower Lias clay, are up to 40 ft. in depth. A well sunk in the gravel in Bourton gives water at any depth from 6 to 12 ft., but in periods of drought many of the shallower wells fail.

In 1852 a well 100 ft. deep and a boring a like depth from the bottom were sunk in the Lower Lias at the Railway Station, but no water was found. The present supply for the station is obtained from the Windrush at the Old Mill about half-a-mile south-west by west of the station. The Lower Lias under Bourton-on-the-Water is probably not less than 500 ft. thick.

The wells of Bourton-on-the-Water are all dry-steined and very few are puddled or cemented to prevent entrance of surface soakage. Though Bourton-on-the-Water is now provided with a sewerage system, not all the houses in the village are as yet connected with the main sewers, so that the wells are still liable to contamination by impurities soaking into the bed of porous gravel.[1]

Proposals have been put forward to supply Bourton-on-the-Water from springs nearby, namely 'Glebe Land Spring' and 'Nicholls Barrow.' Glebe Land Spring is situate on Slaughter Farm land, one mile west-north-west of Bourton-on-the-Water Church. It issues from the base of the Inferior Oolite and Sands. Its yield is unknown, but say seven gallons a minute in wet season, and it is continually running. The water runs into a pond from which some is pumped to the dairy, but the rest runs to waste into the Windrush. Nicholl's Barrow Spring is situate in a field on Bourton Hill, about midway between Clapton-on-the-Hill and Bourton-on-the-Weir.

Whiteshoots House, garden and groom's cottage are supplied with water from a spring on the right bank of the Windrush about half-a-mile up stream from Bourton-on-the-Water. The water is pumped by an engine to a tank in the roof of the house. Originally it was intended to obtain a supply from a well. A well was sunk in the Lias, but the water was found to be undrinkable owing, it is understood, to the presence of sulphuretted hydrogen.

Coldpark Farm is supplied by small springs (thrown out by the Upper Lias clay), one of which is piped into the cattle-sheds.

Bourton Hill Farm is supplied by a well 80 ft. deep through Inferior Oolite to Upper Lias.

Fox Farm is supplied by a well, 95 ft. deep, through Inferior Oolite to Upper Lias (W. H. Hartwell).

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[1] Dr. R. D. Sweeting, 'Report on the Sanitary Circumstances . . . of the Stow-on-the-Wold Rural District, 28*th Ann. Rep. L.G.B.*, 1898-99. Suppl. Containing the Report of the Medical Officer for 1898-99 (1899), pp. 154-158.

Boxwell-with-Leighterton—Maps : 251 ; [34, 35] ; (57 S.W., 65 N.W., N.E.)

The village of Leighterton is on Forest Marble, which embraces beds of clay (with probably a thicker one at the base) that hold up the water which is tapped by the shallow wells and is contained in the pond near the southern end of the village. The supplies obtained from the wells are supplemented by rainwater storage, but in summer the combined supplies are often inadequate. During the drought of 1921 the pond dried up, wells went very low and water for all purposes had to be fetched from White Well.

The following are particulars concerning certain wells[1] :—

1.—About 70 yds. slightly N. of W. of the Church.—20 ft. deep. Good supply, never been known to fail, but fills up somewhat slowly.

2.—35 yds. N. of preceding.—10 ft. 6 in. deep.

3.—100 yds. N.N.W. of Castle Farm.—12 ft. 6 in. deep.

4.—At cottages in the fork of the roads to the S. of the pond E. of Castle Farm—6 ft. deep. Replaced by concrete-lined tank, based on Great Oolite limestones and surrounded by Forest Marble clays, to store rain water.

5.—Near Church.—About 80 ft. deep, through Forest Marble into the Great Oolite. The supply in this well was not good ; there was never more than 4 ft. of water in it. The water became polluted and the well was abandoned and used as a receptacle for the farm drainage.

The Royal Oak Inn, at the northern end of the village, is built on Forest Marble clay, but wells are not relied on ; the supply of water is derived from the roof and stored in a large cement-lined tank.

The cottages some 200 yds. to the north of the Inn depend on rain water stored in tanks. So does the School, the water from off the roof of which is stored in a cement-lined well.

The little village of Boxwell is supplied by springs thrown out by the Fullers' Earth, the water of one of which is pumped by rams to supply the Court and Boxwell Farm.

St. Mary's Well, Boxwell, is now simply an insignificant spring thrown out by the Fullers' Earth, but it makes a stronger appearance in the kitchen gardens.

The thicknesses of the various formations in the parish will be seen from the record of the borehole at the Leighterton Aerodrome (demolished) in Westonbirt-with-Lasborough parish.

Breadstone—Maps : 234, 251 ; [35] ; (48 N.W., S.W.)

The whole of the parish is dependent on wells.

Brimpsfield—Maps : 234, 235 ; [44] ; (34 S.W., S.E., 42 N.W., N.E.)

Some fifteen houses in the parish, constituting part of the hamlet of Birdlip, are supplied from the joint undertaking of the Cirencester and Cheltenham Rural District Councils (p. 79).

E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, informs me that Caudle Green is supplied by spring at bottom of Woodfield House, the water of which is forced by a ram to a tank in the house and overflows to a public tap on the Green. The supply was a little short in 1921.

[1] See L. Richardson, *Proc. Cotteswold Nat. F. C.*, vol. xvi, pt. 1, 1907, pp. 38, 39.

There is another good spring at the bottom of the valley east of Woodfield House, the water of which is collected into a tank into which the occupiers of about five cottages dip for their supply. Caudle Green Farm has a well about 40 ft. deep. In it is 2 to 4 ft. of water, never more, and there was a good supply throughout 1921.

Brimpsfield Park is supplied by gravitation from springs in the valley. A group of cottages at Nettleton is supplied by a spring thrown out by the Fullers' Earth on the north side of the Gloucester road.

Brimpsfield Village is dependent on a few wells sunk in the outlier of Great Oolite resting on Fullers' Earth. The water obtained is good, but inadequate in summer.

Broadwell—Maps: 217; [44]; (22 N.W., S.W., N.E., S.E.).

The public supply (Stow-on-the-Wold Rural District Council) for the village of Broadwell is obtained from a spring issuing from at or near the base of the Sandy Beds of the Middle Lias in a bank in Manor Close, some 50 yds. below the churchyard. The water is caught in tanks near the spring-head from which it is piped to supply taps in the village. There are no wells in use as a source of drinking water. There is a good overflow from the spring in Manor Close, which eventually discharges into the Evenlode. At one time this overflow was considered as a possible source of supply for Moreton-in-Marsh (analysis, p. 248).

In the part of the parish near Stow-on-the-Wold a number of springs issue from the Cotteswold Sands from which they are thrown out by the Upper Lias clay: such are Stow (or the Upper) Well, Horsewell (or the Lower Well), and Humblebee Well, which are dealt with under Stow-on-the-Wold (p. 196).

Brockworth—Maps: 234; [44]; (34 N.W., S.W.)

Out of 104 houses in the parish 29 have Gloucester Corporation water laid on: those not so supplied are dependent on wells in the vale from 12 to 18 ft. deep; but on Cooper's Hill, at the Bungalow, Fiddlers Green, is one 50 ft. deep. The Parish Pump, by the side of the Gloucester-Birdlip road at The Butts, is over a well 14 ft. deep in Lower Lias clay, but an old inhabitant stated that some 25 years ago he laid a pipe from ground "where there were 'chippings' [gravel]" on the north side of the road, across the road, to the well. The water now in the well has been condemned (analysis, p. 249).

A number of springs are thrown out by the Upper Lias clay, some of which are conveyed into the Witcombe reservoirs.

The well at Dean Farm was until 1921 about 10 ft. deep; but in that year, owing to the drought, was deepened, and the water that was good in the shallow well became very saline in the deepened well (analysis, p. 249).

A well at Jubilee Cottage, Green Street, 20 ft. deep, in the Sandy Beds of the Middle Lias, yields a small supply of a potable, but hard and chalybeate water.

East of Brockworth Court is a pit in gravel and at the railing of the field in which the pit is situate a ruined well-house. The water for the well comes out of the gravel which rests on Lower Lias clay.

Bromsberrow—Maps: 216; [43 N.E.]; (10 N.E., S.E.)

The greater part of the parish is situate on the red Upper Bunter Sandstone.

Some 18 out of 60 houses in the parish are supplied from the neighbouring waterworks of the Malvern Urban District Council: otherwise the houses are dependent on wells.

The Bunter Sandstone contains a large quantity of water. On account of the dip of the beds and the land-relief, the water-table is deeper down in the more northern parts than in the southern. At Dick House (282·7 ft. above O.D.) is a well about 150 ft. deep that reached the water-table at 151·09 ft. above sea-level. On Bromsberrow Heath, just within the parish of Dymock, on the other hand, at about 170 ft. above O.D., the wells are shallow and only sufficiently deep to tap water at between 130·70 and 150·26 ft. above O.D.

Bromsberrow Works, Malvern Urban District Council.[1]

These works were constructed during the winter months of 1905-1906. The boreholes and pumping-station are situate on the Grove House Farm Estate—an estate of 52 acres at Bromsberrow Heath which was purchased by the Council.

Bunter Sandstone and Keuper Sandstone and conglomerates occur in a narrow tract running from Bromsberrow to the south of Newent. Under the Malvern Water Act of 1905, this tract was divided into two portions, separated approximately by the River Leadon. The northern portion was allocated to the Malvern Urban District Council: the southern to the Gloucester Corporation.

Borings at Bromsberrow Heath.—Surface-level.—181 ft. above O.D.

Borings (three—two, each 200 ft. deep and 18 in. in diameter: one, 200 ft. deep and 6 in. in diameter).

Bunter Sandstone ... ... 200 ft.

Water-level.—40 ft. below surface-level or 141 ft. above O.D. (analysis, p. 250). On starting pumping the water-level immediately drops 7 ft. and remains at this level, but when pumping ceases it almost immediately reverts to its old level.

The well-pits and two surface tanks, each holding 8,000 gallons, are built in cement. There are two deep well-pumps in the borehole capable of delivering 900,000 gallons per day up to the Camp reservoir. The pipe-track follows the eastern slope of the hills from Bromsberrow, running due north, the total distance being 5¾ miles.

When pumping commenced it was clear that it affected the water-level to the extent of lowering it some 4 or 5 ft. within a half-mile radius of the boreholes. Some of the owners deepened their wells 12 to 14 ft. in anticipation of a shrinkage and retained a supply. The cottages on Bromsberrow Heath in Dymock parish, however, are now supplied with water from a pipe laid and maintained at the expense of the Newent Rural District Council from the Bromsberrow Works.

During the preparation of the case for presentation to Parliament much information was obtained concerning the wells in Bromsberrow parish and contiguous portions of the parish of Dymock. W. O. Thorp has furnished this information which is summarized below. The water-levels are given in terms of their height above O.D. and indicate the natural flow of the water.

[1] Thorp, Wm. O., *Trans. Inst. Water Eng.*, for 1907, vol. xii, 1908, pp. 279, 285-289.

Wells in the neighbourhood of the Bromsberrow Works of the Malvern Urban District Council.

No. of Well	Location of Well	Surface levels above O.D.	Water levels above O.D. June, 1905
36	Well south of the Pound on the north side of the road opposite the School, Bromsberrow	192·03	150·89
35	Well at the Rectory, Bromsberrow ...	—	151·11
34	Well at Dick House, about 150 ft. deep ...	282·47	151·09
26	Boreholes, Bromsberrow Works, Malvern U.D.C.	180·26	150·26
		—	146·89
23			146·62
11	Wells at Cottages on Bromsberrow Heath		143·95
12			145·14
8			135·01
1		170·20	130·70
4	Well at cottage, adjoining Post Office, Bromsberrow Heath. Water went completely, having sunk some 5 ft.		132·16
44	Well at Smithy, Bromsberrow	208·58	145·87
43	Well at Little Linbridge, Dymock ...		141·85
45	Well at Great Lintridge, Dymock		134·58
21	Well at Ryton, Dymock		108·17
20	Well at Ryton, Dymock		107·37
18	Well at Smithy, Ryton, Dymock		105·41
	Well at Cabbage Stump, half-a-mile north by west of Bromsberrow Church ...	239·00	158·25
	Well at Russell's End, Bromsberrow ...	155·80	
47	Well at Letter House (level of Glynch Brook near Letter House, 156·90 above O.D.) ...	169·10	147·10
48	Well at Bromsberrow Court	169·43	
	Well at cottage 300 yds. north-west of Bromsberrow Court (Level of Glynch Brook near cottage 171·07 ft. above O.D.)	178·62	151·87
	Well at Great Heath, Dymock	149·03	132·37
	Well at Little Heath, Dymock	146·60	

Brookthorpe—Maps: 234; [43 S.E., 44]; (33 S.W., S.E., 41 N.W., N.E.)

Brookthorpe water-supply is derived from springs just below Seven Leas Lane and the highest is about 400 ft. above O.D. The spring-water is led into four drinking-troughs for the cattle and into a fifth where a supply is added from "blue Lias clay." It is then conveyed to a covered-in brick tank of about 3,500 gallons capacity. Water from this tank runs into a well in the basement of the late Lady Darwin's house for the supply of the house, and also in a 4-inch iron pipe to Wynstone Place, and from thence in a smaller pipe to an open reservoir of about 55,000 gallons capacity. From this large reservoir a part of the village is supplied by gravitation; other people have to pump from the reservoir. The water is hard, but good (analysis, p. 251). and the supply adequate. When certain 4-inch pipes, which had been in for 50 years, were taken out, the late J. M. Collett informed me, they "were nearly filled up with calcium carbonate, only one inch of room being left out of the 4 inches."

A number of the villagers fetch their water from a small pond—fed by water running out of a gravel-bed, in the lane opposite the blacksmith's shop. The wells in use in the village are from 25 to 30 ft. deep.

Buckland—Maps: 217; [44]; (6 S.E., 13 N.E., 14 N.W.)

The springs (marked on the six-inch map) $\frac{5}{12}$ mile S.S.E. of Buckland Church, contribute to the Evesham supply, the water being piped to a service reservoir at a lower level, but in the same field. The reservoir $\frac{1}{6}$ mile distant from the church in a south-south-easterly direction supplies the Manor House. The village supply is drawn from near the disused corn-mill, now farm-buildings, where there is a reservoir of 2,500 gallons capacity. The water is said to be piped from springs up the hill-side (analysis, p. 251).

The hamlet of Laverton is supplied by a spring (analysis, p. 251) issuing from the base of the Cotteswold Sands in a field called 'Cow Hill.' The water is conveyed to two catch chambers near the withy-bed and eventually to a reservoir[1] (2,500 gallons) situate a $\frac{1}{4}$ mile E. by N. of Hill Crest House whence it gravitates to standposts in the hamlet.

There are several springs issuing from at or near the base of the Sandy Beds of the Middle Lias in the parish.

Bulley—Maps: 216, 234; [43 S.E.]; (24 S.E.)

Village and parish on the Keuper Marl are dependent on wells.

Cainscross—Maps: 234; [34, 35]; (41 S.W., S.E., 49 N.W., N.E.)

Cainscross and Ebley are served by the Stroud Water Co., but Derryhay Public Spring, situate some 200 yds. east by north of the Chapel, Ebley, is used by the surrounding cottages. The water issues from the gravel bed, flows continuously, and, except what is used as above mentioned, runs to waste into the Stroudwater Canal. Westrip is dependent on wells tapping water in, and springs issuing from, the base of the Cotteswold Sands.

The Ruscombe Brook flows along the eastern side of the parish, through ponds near Cainscross Brewery, and discharges into the Frome.

Cainscross Brewery (Messrs. Carpenter Ltd.). Messrs. Carpenter inform me that they obtain their supply from wells tapping springs at (1) Puckshole, a hamlet between Paganhill and Randwick. Well, 6 ft. deep in limestone. Yield 4 gallons a minute. The water is of a chalky type, out of 31·21 grains per gallon of saline matter, 22·99 correspond to carbonates of lime and magnesia, and 8·22 consist of permanently soluble salts. (2) The Dairy Farm between Puckshole and the Brewery. Well, 12 ft. deep. Yield about 12 gallons a minute. The water is turbid owing to suspended particles of iron and calcium hydrates. It is a mild mineral water containing 3·5 grains per gallon of Fe_2O_3. Total solid matter=55 parts per 100,000; combined chlorine=5·7. Nitrates and nitrites=nil. Mineral ammonia=·047; organic ammonia=·002.

Hamwell Leaze Brewery, Cainscross (Messrs. Cordwell & Sons). Messrs. Cordwell & Sons inform me that they obtain their their water for brewing purposes from a well, while for cleaning town water is used. They have supplied the following particulars concerning their well, the ground level at which is about 200 ft. above O.D.

Total depth 50 ft.; diameter 3 ft.; depth to rest-level of water, 44 ft.; nature of beds in which sunk, Lower Lias clays (near the top). Quality of water—very satisfactory for brewing purposes.

[1] Marked "W" on the six-inch map, 14 N.W.

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Cam—Maps: 234, 251; [35]; (48 N.E., S.W., S.E., 49 S.W., 56 N.E.)

The water supply of Cam is not too satisfactory. There are numerous, mostly shallow wells in use, the water in which in many cases, owing to bad construction of the wells, is polluted during heavy rains by the entrance of surface water, and in other cases is deficient in quantity in summer. The public supplies are small.

At Upper Cam a spring (? issuing from at or near the junction of the Middle and Lower Lias) near the surface-level 265 ft. above O.D. on the 6-inch map, about ⅛ mile W. of Downhouse Farm, is piped to a tank from which the water gravitates first to Church Farm, thence to a tank (150 gallons) which supplies two public (Dursley R.D.C.) standposts; while the overflow goes to the Vicarage.

At Lower Cam a spring issuing from at or near the junction of the Middle and Lower Lias in 'the Craught,' near Cam Mills, is conveyed to a tank from which the water is piped to standposts in Station Road and for the use of Rowley Cottages. There are also two public pumps (Dursley R.D.C.) drawing from wells about 12 ft. deep (in Lower Lias) and while they usually have about 8 ft. of water in them that at the bottom of Cam Pitch occasionally runs dry.

The houses at the 'Garden City' have wells from 11 to 16 ft. deep in Lias (about the junction of the Middle and Lower Lias), the water in which stands at about 2 ft. below the surface of the ground.

A well at Middle Mills is about 80 ft. deep in Lower Lias and occasionally runs dry.

Each of the Draycott Cottages has a well and the deepest holds out the longest. These are in the Capricornus Beds, for when one was sunk there were obtained from rock thrown out some of the characteristic fossils.

Beyon House and Steps Farm have a piped supply from a spring issuing from at or near the base of the Middle Lias near The Knap. Cam Mills (Messrs. Hunt & Winterbotham) are supplied from a spring the water from which is softened in an extensive plant near the road between Cam Station and the School.

King's Hill House, Hill's Square, and other buildings are supplied from a spring which issues from near the base of the Middle Lias between Hill's Square and the Gas Works. The water is pumped up by rams and a strong overflow runs out of a pipe into a bricked recess by the road-side, from which it runs to waste into the River Cam. The water is very irony, as is indicated by the reddish deposit on the bricks of the recess.

Woodfield Lodge and fields are supplied from a well, 80 ft. deep, through the Marlstone and into the beds below. The water is pumped up by a wind-pump to a reservoir to the south (at the foot of Stinchcombe Hill) from which it gravitates.

A main from Dursley Waterworks is laid along the road through Sandpits and to the house called Norman Hill.

The Quarry hamlet is on a portion of a fine, open platform of Marlstone, which is incised by a valley that has been cut by water coming from near the Yew Tree Inn. Lower down this valley, in Ell Bottom, a spring issues from at or near the base of the Middle Lias. The hamlet is dependent on wells from 20 to 80 ft. deep. Mr. Malpas informed me that water was met with at two horizons—the 'upper spring' at 25 ft. below the Marlstone: the 'lower spring' at 45 ft. below the Marlstone or thereabouts. A well in Mr. Malpas's quarry is 80 ft. deep, enters the Capricornus Beds[1] and taps the 'lower spring.'

Boring at Stinchcombe Hill House (at the 'd' in 'Wood' of Hillside Wood on 6-inch map 56 N.E.).

[1] *Proc. Cotteswold Nat. F. C.*, vol. xvi, pt. 1, 1909, p. 216.

Made for A. A. Lister, and particulars communicated by Messrs. LeGrand and Sutcliff. Boring commenced 8th May, 1905, finished 28th June, 1905. Surface-level 600 ft. above O.D.

		Thickness Ft.	Depth Ft.
[Inferior Oolite]	Dug Well :—		
	1. Oolite	20½	20½
	Boring :—		
	1a. Oolite	69½	90
[Cephalopoda Bed]	2. Yellow loamy clay ...	1	91
	3. Rock	4	95
	4. Rock and thin beds of clay	5	100
	5. Rock	4	104
[Cotteswold Sands]	6. Rock and bands of yellow sandy clay	26	130
	7. Rock and bands of dark blue clay	4	134
	8. Rock and bands of yellow sandy clay	33	167
	9. Hard yellow sandy clay ...	33	200
	10. Rock and hard yellow sandy clay	21	221
	11. Hard yellow sandy clay ...	4	225

This borehole did not yield any water and was therefore abandoned. Instead, a well was sunk, 35 ft. deep, through some Upper Lias clay and limestones (which yielded species of *Harpoceras*[1]) into the Marlstone in the field between the Yew Tree Inn and the hill. The water is pumped to a large tank near Stinchcombe Hill House, whence it supplies the house, a farm and some cottages.

Chalford—Maps: 234; [34]; (50 N.W.)

The two horizons at which water issues are the base of the Great Oolite and at or near the base of the Cotteswold Sands. The most densely populated parts of the parish—France Lynch, Chalford Hill, Brown's Hill and Bussage—are in part on the basement-beds of the Great Oolite and in part on the Fullers' Earth where water could be readily obtained by wells or from springs. Below Chalford Hill (Rack Hill), however, the houses extend downwards, clinging as it were to the steep valley side in which Inferior Oolite crops out. Rack Hill is supplied partly by the Stroud Water Company and partly by wells, some necessarily deep, and springs in the bottom, such as Tankard's Spring.

Numerous small springs are thrown out by the Fullers' Earth in France Lynch, the strongest being that south-east of the church. The water from these springs runs to waste down Dimmel's Dale and into the Frome at Hell Corner. A fairly good stream rises at Old Neighbouring (Chalford Lynch) and flows down the valley past Chalford Hill Schools.

D. Lewis Grist informs me that a good stream comes out of the north side of the valley near the Queen's Head Hotel and is taken under the canal (after having been joined by another stream from under Whareham's Hill) and discharges into the Frome.

(For the Chalford Springs and Stroud Water Company, see p. 119.)

Charfield—Maps: 251; [35]; (56 S.W., 64 N.W.)

Charfield village and parish are dependent on wells.

Two wells sunk in the Keuper Marl west of Charfield Station are respectively 20 and 30 ft. deep and yielded a good supply of water throughout 1921.

[1] *Proc. Cotteswold Nat. F. C.*, vol. xvi, pt. 1, 1909, p. 215.

Charlton Abbotts—Maps: 217; [44]; (20 S.W., S.E., 27 N.W., N.E.)

Charlton Abbotts village is supplied by a spring thrown out by the Upper Lias. This spring was reported on by Dr. T. Wright and D. J. Humphris in 1863 as a possible additional source of supply for Cheltenham: —" The water issues from the rock by the side of the road, and is conducted in a wooden channel into a sheepwash; the stream is strong and rapid, and yielded on the 14th Oct., 1863, 36 gallons per minute, or 51,840 gallons per diem. The stream flows from the sheepwash towards the eastern side of Willis Coppice . . . ; it then enters that enclosure, and there receives several tributary branches."

There are now two rams below the sheepwash: one forces up water to a reservoir in the field west of the Sevenhampton-Winchcomb road; the other to Brockhampton Park. From the reservoir the water gravitates to supply Charlton Abbotts.

Numerous springs break out in the neighbourhood of Charlton Abbotts, forming streamlets that flow into the Babesmore Brook. Such are the Lyefield Springs, between Willis Coppice and the Sevenhampton-Winchcomb road, and that ¼ mile south of Holt Farm. There is also a good spring at Cotehay.

Chedworth—Maps: 235; [44]; (35 S.W., S.E., 36 S.W., 43 N.E., 44 N.W.)

The village of Chedworth is on the side of a valley traversed by a stream which rises in springs near the church and joins the Coln at Fosse Bridge. In this valley, in the neighbourhood of the village, the Fullers' Earth crops out in the sides all around and throws out springs, while the bottom of the valley is hollowed out of the Inferior Oolite. It is supplied by wells and by springs, all of which latter are thrown out by the Fullers' Earth. Some of the wells on the higher ground are up to 60 ft. in depth (through the Great Oolite). Near the church some good springs issue. Close to the church is Holy Well: in a farm enclosure to the south two good springs, which formerly formed a fine cascade in the "Poor Land." Subsequently water from these springs was taken for the supply of the Manor Farm buildings. A copious overflow is discharged through a pipe into a dip opposite the Seven Tuns Inn. This is drawn on by those living in the vicinity, but as the water runs along an open course by the road-side above the derelict water-wheel house it becomes turbid with storm water from off the road and when such is the case water has to be fetched from Holy Well.

From the dip opposite the Seven Tuns Inn some of the water runs through a grating, underground for a space, and reappears down Queen's Street, along the side of which it flows. In a recess in the well in Queen's Street is a stone trough fed, per pipe, from another spring. This supply is used by those living in the vicinity.

At Well Hill, near the station, is a spring, the bulk of the water from which is used for the supply of the Police Station and a private house. Water from a small spring is pumped by ram to supply Hart's Hill Cottages.

Chedworth Tunnel cuts through the bottom-beds of the Great Oolite and Fullers' Earth. The water in the bottom beds of the Great Oolite was therefore encountered. This water, a strong 'spring,' is delivered by a ram to the limestone works near Foss Cross station. Surplus water runs into a sump below the 6-ft. way (in the tunnel) from which, it is understood, it escapes through a fissure in the subjacent Inferior Oolite.

At seven-eighths of a mile N.W. by N. from Chedworth Church a good spring is thrown out by the Fullers' Farth on the edge of 'The Downs.' It has been collected, and discharges through a 1½-inch pipe into a trough. On January 11th, 1928, this pipe was 'running full.' Water from this spring is pumped into a tank on 'The Downs' from which Newport Farm, certain grounds and The Down Barn are supplied.

A draw-well in Great Oolite at Pinkwell is 47 ft. deep, and on 9th Sept., 1922, had water standing in it at 19 ft. from the surface. The water in the wells here becomes very ' brown ' in wet weather and has disappeared several times in dry periods, so water is fetched from troughs in the fields which are supplied from Rendcomb.

Cherington—Maps: 251; [34]; (50 S.W., 58 N.W.)

Cherington parish is for the most part on Forest Marble. Great Oolite crops out from beneath the Forest Marble in the sides of the deep narrow valleys which converge on Cherington Lake, which is on Fullers' Earth. The springs in the vicinity of the Lake are thrown out by the Fullers' Earth.

The village of Cherington is supplied by an undertaking belonging to the Misses C. L. and G. E. George of Cherington Park. The source of supply is a spring issuing from the bank by the road-side near the south-western extremity of Cherington Lake. The spring water is pumped to a reservoir (7,000 gallons) in the Park, from which it is piped to the house and to a tap on the village Green from which all the villagers draw their supplies. Westrip and Grove Farm are supplied from the same source.

Boring at Grove Farm.—Made in 1903 by, and particulars communicated by Messrs. Thomas Tilley & Sons, Cromwell House, 6 and 8, Surrey Street, Strand, London, W.C.2.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
[Forest Marble and Great Oolite]	1. Top soil	6	0	6	0
	2. Grey rock...	104	0	110	0
[?Passage Beds]	3. Blue rock...	33	0	143	0
	4. Blue rock...	5	0	148	0
	5. Blue rock...	2	0	150	0
	6. Veins of clay and rock	9	0	159	0
	7. Hard blue rock	6	10	165	10
	8. Very hard rock (water) ...	4	0	169	10
[Fullers' Earth]	9. Blue clay and veins of rock	5	6	175	4
	10. Blue rock...	2	0	177	4
	11. Clay and rock	3	6	180	10
	12. Grey rock (water) ...	5	0	185	10
	13. Grey rock and clay ...	5	2	191	0
	14. Dark grey rock ...	5	0	196	0
	15. Blue rock and clay ...	10	0	206	0
	16. Blue clay and veins of rock	5	10	211	10

Water-level varied between 86 ft. 6 in. and 95 ft. below surface, but stood at 95 ft. on completion of the boring. Pumping at the rate of 315 gallons per hour did not lower the water-level below 116 ft. ex surface. The water failed in 1921, so the farm was linked up with the Cherington supply.

The boring is through Forest Marble, Great Oolite, Passage Beds and Fullers' Earth to very near the bottom of the last. The particulars available are insufficient to indicate precisely the limits of the several formations.

Childs Wickham—Maps: 200, 217; [44]; (6 S.E., 7 S.W.)

The part of the village near the School is on sand, 4 to 5 ft. thick; the other part mainly on Lower Lias clay.

The water-supply is obtained from the Childs Wickham reservoir adjacent to, and which derives its supply from, that of the Evesham Corporation on the high ground (257·9 ft. above O.D.) about ½ mile north-east of the village. Some of the houses have cemented wells into which runs water from the roofs. Near Brixley Cottage is a well in the sand-bed, 5 ft. deep, which is always full of water.

The hamlet of Murcot, in the parish of Childs Wickham, consists of a few houses on Lower Lias clay. There is no public supply, water being obtained from shallow wells.

Boring at Murcot.—Made early in 1921 for the Murcot Co-operative Housing Society in search of water to supply sixteen houses newly erected. The site is 180 yds. W. of B.M. 138·9 (six-inch map 6 S.E.), or ¼ mile W. by S. of Millbrook Farm. The boring was 60 ft. deep in Lower Lias.[1] Such water as was obtained was a 'mineral water' and unfit for drinking purposes (analysis, p. 254).

Chipping Campden—Maps: 200, 217; [44]; (7 S.E., 8 S.W., 14 N.E.)

Chipping Campden derives its water supply from an undertaking provided by the Campden Rural District Council, from wells (4 to 60 ft. deep) and from springs. The springs from which the Council obtains its water are situate on Westington Hill, a mile and a quarter S.W. by S. of Chipping Campden Church. The water is collected and piped to a reservoir a little to the west by south or about 1½ miles south-west of the Church. The average daily yield of the springs, in normal times, is 35,000 gallons, but during the drought of 1921 it was diminished to 14,000 gallons. The total hardness of the water is 11·62°; permanent hardness, 4·47°. In 1920 a scheme was prepared for securing an additional supply from Maiden's Well, near Broad Campden.

The 'Conduit House,' Westington Hill, formerly supplied Campden House and the Almshouses, but now, only the latter.

Chipping Sodbury—Maps: 251; [35]; (69 S.W.)

Some 196 out of 268 houses are served by the West Gloucestershire Water Company: those not so supplied are dependent on wells and springs. Some people use the "soft" well-water for washing and the Company's "hard" water for drinking.

The Divisional Engineer of the Great Western Railway informs me that the water encountered when the Sodbury Tunnel was being constructed,[2] supplies only Chipping Sodbury Station.

Churcham—Maps: 216, 234; [43 S.E.]; (24 S.W., S.E., 32 N.E.)

Village and parish, which are on Keuper Marl, are dependent on wells, which yield sufficient water for a continual supply. The well at Churcham Court is about 70 ft. deep.

Churchdown—Maps: 216, 234; [44]; (25 N.E., S.E., 26 N.W., S.W.)

The greater part of this parish is on the Lower Lias, but locally on the surface of the Lias, as under the greater part of the village, is sand.

Out of 300 houses 117 are supplied with Gloucester Corporation water: those not so supplied are dependent on wells from 10 to 15 ft. deep. The wells in the Lower Lias frequently yield a mineral water: sometimes so highly mineralised, as at 'Rosedale' (15 ft. deep), as to be undrinkable. Indeed, in this lower part of Churchdown, newcomers are considerably affected by the well-waters until they become accustomed to them.

Church Iccomb—(See Iccomb)

Clapton—Maps: 235; [44]; (28 S.E., 29 S.W., 36 N.E., 37 N.W.)

The village is not well situate for the provision on the spot of an adequate supply of water. The wells are from 15 to 20 ft. deep.

[1] In 1831 a shaft was sunk in the Lower Lias at Bretforton, 3 miles N.E. of Murcot, in search of coal. The shaft proved 300 ft. of Lower Lias without reaching its base.

[2] Some particulars are given by H. B. Woodward in 'Summary of Progress' for 1898 (*Mem. Geol. Surv.*), 1899, p. 190; and *ibid.* for 1901 (1902), p. 59.

Clifford Chambers—Maps: 200; [54 S E.]; (2 S.W., 4 N.W.)

The village is situate on gravel and sand alongside the River Stour.

Some of the houses have water laid on from the Stratford-on-Avon supply, but the majority are dependent on wells sunk in the gravel-and-sand deposit. Most of the wells are covered over and fitted with pumps.

The following are particulars of the principal wells obtained by B. G. Chilcott. At New Inn, two wells: (*a*) 15 ft. deep. Dry and abandoned; (*b*) 30 ft. deep, rather short in dry periods. At the Old Rectory: never fails, water clear but hard. In 'The Lane,' north of the Church: plenty of water, good but hard. At 'The Lindens': 27 ft. deep, probably through some gravel, but mainly in red Keuper Marl. The supply is good, and has not been known to fail.

Clifford Hill farm, farm-buildings and cottages are on rising ground and are supplied from a well, 16 ft. deep, in Lower Lias, situate on the low ground to the south. The water is pumped up by a windmill. The supply is adequate, and has not been known to fail, but the water is hard.

Boring at Willicote House (Campden Road, Clifford Chambers).—Made in 1922 for R. F. Lee. Particulars communicated by Mr. Lee.

Boring (6-inch diameter; first 80 ft. jumped: remainder, shot bored):—

Lower Lias	Numerous thin layers of argillaceous limestone with thin partings of clay	490 ft.

Boring abandoned: no water.

Clopton—Maps: 200; [44, 54 S.E.]; (3 S.E., 4 S.W., 8 N.W.)

Wells have been sunk at or near the junction of the Sandy Beds with the Lower Lias, but the few houses are not dependent thereon as they have a piped service from the supply provided by S. G. Hamilton for Mickleton.

Coaley—Maps: 234, 251; [35]; (48 N.E., S.E., 49 S.W.)

A number of springs issue from at or near the base of the Cotteswold Sands in the extreme south-eastern portion of the parish below Coaley Wood and from two of these the parish derives its public supply (Dursley Rural District Council).

Coaley Village is on Lower Lias clay. Water is laid on to 61 houses (out of 160 in the parish) and to standposts down the main street of the village. The original source of supply was Spring Tyning (analysis, p. 256) between the Moors and Coaley Wood (on the one-inch map, Sheet 251 (N.S.) $\frac{1}{16}$ inch south-west of the W. in Coaley Wood). In 1900 water from a spring 200 yds. south-south-west of Spring Tyning was added and piped to a small reservoir in the northern corner of the field. In September, 1921, Spring Tyning had ceased to flow, but the other spring was yielding 24,000 gallons a day. The water gravitates from the reservoir and the pressure is high, somewhat inconveniently so.

The County Council Cottages at Wisloe have Coaley water laid on (p. 152).

Between the two springs furnishing the Coaley Supply and at Knapp Farm are springs used for watering the cattle, but otherwise running to waste.

In their Report to the British Association for 1877 (1878, p. 401), the Commissioners on Underground Water Supplies say: "At the base of the Inferior Oolites powerful springs are thrown out, and flow in streams and rivulets over the Lias plain at their base. The commissioner gives several examples of clay-land parishes of this character in the valley of the Severn, which at present do not receive their water supply until it has been hopelessly contaminated, with one marked exception, that of Coaley, near Frocester.

"The common lands of this parish were enclosed under the superintendence of a Deputy Commissioner of the Enclosure Office. The frontages of the

highways were fenced in, and the footpaths to the brooks closed ; the several landowners who benefitted by the enclosure in return laid a two-inch iron pipe from the spring through every hamlet in the parish and built a small reservoir at the spring head."

Houses in the parish not supplied from public sources are dependent on wells, the wells in the village being from 10 to 15 ft. deep, but their waters are not in use for potable purposes.

W. Webb, Sanitary Inspector, Dursley Rural District Council, has supplied me with the following information :—

Locality	Depth of well in Ft.	Depth of water in well in Ft.	Remarks
Silver Street	2 to 10	Generally full	There is a private piped supply to the farms and a few cottages [from a spring, issuing from a gravel bed resting on Lower Lias clay, 100 yds. S.E. by E. of Silver Street Farm].
Garter Court	30	6	Supply good.
Pinnels End Farm ...	8	—	Not used : connected with main.
Corner Farm	6	full	,, ,, ,,
Lapley Farm	12	6	,, ,, ,,
Elmcote	60 to 80	10 to 20	,, ,, ,,
Hillhouse Farm ...	40	6	,, ,, ,,
Leigh Farm	18	7	Never known to fail.

Coates—Maps : 235, 252 ; [34] ; (50 S.E., 51 S.W., 58 N.E., 59 N.W.)

Coates is supplied from a well, which was sunk in 1899-1901, at Coatsfield Bridge, near Trewsbury House. The well is 80 ft. deep (through Forest Marble into Great Oolite) 8 ft. in diameter at the top and 4 ft. at the bottom, and yields about 1,200 gallons an hour. The level of the water is said to be affected by strong winds. In November, 1906, there were 30 ft. of water in the well, but it ran somewhat low during the summer of 1921, although the level could not be reduced, by pumping, below 7 ft. (of water). The water is raised by pumps, operated by an oil engine (pumps and engine in duplicate), through a 4-inch main to a circular cement reservoir (16,000 gallons), from which it is laid on to the Manor House, Thatched House, Glebe Farm, Church Farm, Rectory, nine small houses, and nine standposts in the village.

Trewsbury Well is situate between the canal and the bank of the Trewsbury Roman Camp, near the B.M. 366·5 east of Tarltonfield Barn (six-inch map, Sheet 51 S.W.). The well is 54 ft. deep in Great Oolite, and the rest-level of the water fluctuates with the seasons : it went dry during the drought 1921. The water is raised by pumps operated by an oil engine to a reservoir (4,000 gallons), whence its supplies Trewsbury House, farm and five cottages.

In a letter dated 9th Oct., 1892, to W. Topley, Prof. Allen Harker wrote :— " A well has been sunk recently not very far away (not 100 yds.) from the old source of the Thames. You may remember that before the Canal Company

put in their pumping engine, the Thames rose in 'Trewsbury Mead,' now it rises quite half a mile or more further down below its old source. The 'Trewsbury New Well,' is close to the old source and is 54 ft. in depth. The water is pumped from it to the Castle [Trewsbury House]. It varies with the seasons."

Coberley—Maps: 234, 235; [44]; (34 N.E., S.E., 35 N.W., S.W.)

Coberley village obtains most of its water from the fine spring that issues from the foot of the wall on the south side of the road opposite the Post Office. The spring flows into the stream called 'Ullen Water,' a tributary of the Churn. Coberley Court is supplied (by ram) from the stream to the east, near the Leaden Wells.

Upper Coberley is supplied with water running off a small outlier of Fullers' Earth. The water is piped to a cement-lined catch well from which it is pumped to a small reservoir. Upper Coberley Cottages have a cement-lined well, 8 ft. deep, which catches surface water.

A number of small springs occur at the head of Pinswell Bottom valley: the majority issuing from the Cotteswold Sands. Lower down stronger springs isssue from the Sands.

Just above the 'd' in 'Needlehole' on the one-inch map, Sheet 235, is a "swallow-hole" (p. 27).

The Seven Springs, locally claimed as the source of the Thames, rise in a hollow by the side of the Gloucester-Oxford road at about 650 ft. above O.D. Phillips wrote that they rise "through joints in the solid [Inferior Oolite] rock."[1] The bulk of the water comes from the direction of Hartley Bottom, but some no doubt travels below ground along the line of the dry depression that runs from the north of the springs on to the Rifle Range (analysis, p. 257). According to gaugings, the yield has varied from 100,000 to 3,780,000 gallons per day.[2]

Wells at Salterley Grange.—Salterley Grange was opened in 1908 as a Sanatorium for Consumption by the Birmingham City Council.

Sir John Robertson, late Medical Officer of Health for Birmingham, informed me that there are seven wells on the estate, a number of which have been adandoned. Well No. 1.—Situated in the enclosure near Salterley Oak on the west side of the Cheltenham Road and close to the fault. "This is a shallow well fed by a spring [doubtless thrown out by the Upper Lias], apparently going down through the Inferior Oolite, and it is insufficient to supply the Grange. We do not use it therefore except in case of emergency."

Well No. 2.—"This is a shallow well situated at the Lodge. It gives a very bad supply and dries up in dry weather." [J.R.] Probably it is in tumbled Oolite and Cotteswold Sands from which the water would soon drain owing to their position on the divide between Severn and Thames streams.

Well No. 3.—"This well is situated at the Grange and was found to be contaminated by surface drainage. It is said to be 100 ft. deep. It was certainly polluted when the City Council took over Salterley Grange and has been abandoned." [J.R.].

Well No. 4.—"This well is situated at Hartley Cottages and is 226 feet deep, going down through Inferior Oolite. This well gives a totally inadequate supply of water and has been adandoned as a source of supply to the Institution. The former tenant of Salterley Grange [T. E. Williams] made use of this well, together with No. 1 for his supply. I have been down this well on a number of occasions and found the Oolite perfectly dry until one gets to the bottom of the well. In view of this it was thought to be undesirable to spend money by sinking lower." [J.R.].

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[1] "Geology of Oxford" (1871), p. 29.

[2] W. Pole, *Rep. Roy. Comm. Water Supply*, 1869, Appendix O, p. 67; J. H. Taunton, *Proc. Cotteswold Nat. F. C.*, vol. xi, pt. 1, 1893, p. 58.

This well was cleaned out, deepened, and a boring made to ascertain whether an additional supply of water could be obtained by sinking deeper, shortly after the purchase of the estate. The following particulars were obtained at the time[1] :—

Well, 226 ft. 1 in. deep.

		Ft.	In.
Inferior Oolite	? Clypeus Grit and Upper Trigonia Grit ...	12	4
	Beds between the Upper Trigonia Grit and Upper Lias...	200	0
Cotteswold Sands	1. Hard, greyish-blue sandy micaceous clay	3	9
	2. Yellow ferruginous, micaceous, indurated sandy clay; *Nautilus*, belemnites (phragmacones), small *Gryphaeae*	1	0
	3. Greyish-blue clay similar to 1	6	4
	4. More arenaceous but otherwise similar clay	1	0
	5. Greyish-blue sandy rock: *Belemnites* (near to *B. tubularis* Young and Bird), *Haugia grandis* S. Buckman, *Haugia* sp. indet., *Dactylioceras* cf. *holandrei* (d'Orbigny), *D. mucronatum* (d'Orb.), *Thysanoceras* sp. (fragment—? *sublineatum* (Oppel)), *Entolium demissum* (Phillips) auctt., *Pleuromya* sp.	1	8
Boring: 35 ft.	6. Sandy clay	11	9
	7. "Very fine blue sand": penetrated ...	23	3
	Total	261	1

Before deepening the well the water stood at 210 ft. 1 in. down in the Scissum Beds, being held up by the sandy clay, but on deepening it ran away at 226 ft. 1 in. from the surface.

Well No. 5.—"This well supplies two labourers' cottages. It is a shallow well and is likely to dry up in the summer time." [J.R.].

Well No. 6.—"This is 55 ft. 3 in. deep. It gives a fair supply of water to Hartley Farm, but a defective supply during dry weather." [J.R.].

Well No. 7.—This well is situated in the upper part of Hartley Bottom at Tumbledown Cottages. It was sunk in 1911, is 145 ft. deep, commences in the Oolite Marl and leaves off in the sandy clays of the Upper Lias.[2] "So far, it has given an excellent supply, and is the only well now in use for the Institution except when a breakdown takes place. The Oolite is dry until near the bottom." [J.R.].

Henry Bubb, of Ullenwood, has supplied me with the following particulars concerning the water resources of his estate :—

1.—The spring near the B.M. 631·8 on the 6-inch map, Sheet 34 N.E., ⅓ mile W.S.W. of the Air Balloon Inn is very constant and supplies the whole of the neighbourhood in a dry period. 2.—A spring a little higher up the road feeding the trough near the 700-foot contour-line is very small, but has never been known to cease flowing. 3.—Spring 120 yds. W. of the Reservoir, ⅓ mile S. of Ullenwood, is fairly constant, but it has been known to cease flowing. 4.—The spring close to the reservoir is very constant and even. 4a.—A spring between (3) and (4) at a slightly higher level, usually fails towards the end of the summer. 6.—"Ullenwood Pond" is supplied by a very constant spring

[1] Richardson, L., *Geol. Mag.*, dec. v, vol. vii, 1910, pp. 101-104.
[2] Not 'in the Pea-Grit' as stated in *Geol. Mag*, 1910, p. 103.

(700 ft. O.D.) that has never been known to fail. 7. and 8.—There are two wells near the house: (7) on the north side, which had a good reputation as to quality and quantity until about 25 years ago, when it suddenly became undrinkable; and (8) on the south side, which is only used occasionally for garden purposes. 9.—A surface spring in the field to the north of the house. 10.—Near "The Lodge" on the Gloucester-Oxford Road is a surface spring. 11.—At 'Oxford Cottages' is a very constant spring. 12.—At Cuckoopen Barn water is collected off the roofs.

All the springs mentioned above are thrown out by the Upper Lias clay.

Cold Ashton—Maps: 265; [35]; (73 S.E., 77 N.W., N.E.)

Cold Ashton village is on the basement-beds of the Great Oolite just above the Fullers' Earth and is dependent on wells and springs.

The parish as a whole is dependent on wells and springs. The majority of the springs in the upper portion of the St. Catherine's Valley (which is in this parish) are piped to the Monkswood Reservoirs of the Bath Corporation (p. 115). A fair quantity of water issues in the upper part of the Langridge Valley, especially to the east and the north-east of Hill Farm, and runs to waste.

At Hamswell is a well called 'St. Ann's Well.'

Water collecting on the Fullers' Earth between Cold Ashton and Pennsylvania, augmented by small springs issuing from the base of the Great Oolite to the north of The Folly, constitute the headwaters of the southern tributary of the Broadmead Brook.

Colesborne—Maps: 235; [44]; (35 N.W., S.W., 43 N.W.)

Some springs issuing high up on the side of Pen Hill from the basement-beds of the Great Oolite, by an undertaking provided by the late H. J. Elwes, F.R.S., of Colesborne Park, provide water which gravitates to Penhill Farm and to two standposts in the village. A group of strong springs, known locally as 'Wine's Well,' issue from the neighbourhood of a fault that runs near the village. Water is taken from them, through a 2-inch pipe, to pumps which force the spring-water to a tank (2,000 gallons) from which Colesborne Park, Old Farm, Southbury Farm, School and Colesborne Inn, are supplied. There is a tap at the rear of Colesborne Inn from which the cottagers in the vicinity fetch their water.

A little to the west of Wine's Well, but issuing from the Cotteswold Sands on the south side of the Churn, is a spring, water from which is forced up by a ram to the Colesborne Inn and two or three adjacent cottages, but it is understood that this supply will be, later on, dispensed with. There is a good perennial spring above Southbury Farm on the line of fault.

A strong perennial spring, thrown out by the Fullers' Earth, is at present running to waste below Rapsgate Park House.

Coln Rogers—Maps: 235; [34, 44]; (43 N.E., S.E., 44 N.W., S.W.)

Coln Rogers village is supplied by wells, which all appear to have water at about river-bed level. The Rectory is supplied from a well. There are two shallow wells in the village supplying cottages.

The high ground is practically bare of habitation.

Boring on Coln Rogers Estate.—Field 79 on 1921 Edition of Ordnance map. Made in 1924 for Ecclesiastical Commissioners by H. J. Godwin, Quenington, Fairford, Gloucestershire, and particulars communicated by Messrs. Clutton, Gt. College Street, Westminster, S.W.1. Height above O.D. about 500 ft. Through Great Oolite into Fullers' Earth.

	Thickness Ft.	Depth Ft.
White stone	35	35
Heavy hard block stone	60	95
Hard blue marl	5	100
Soft white stone	6	106
Hard blue clay	2	108
Hard stone	13	121
Soft white stone	6	127
Fullers' Earth clay	3	130
Stone and clay mixed	3	133

Pumping test at rate of 8 gallons per minute easily obtained for several hours.

Coln St. Aldwyn—Maps: 235; [34, 44]; (44 N.E., S.E., 45 S.W., 52 N.E.)

This parish is supplied with water from the River Coln, which is filtered and laid on.

An undertaking has been recently completed by which water is pumped (at the back of the saw-mills, formerly a grist mill) to (north of the Coln) Knoll Barn, Swyre Farm, Moor's Farm and Williamstrip Farm, and (south of the Coln) to Conegar Farm and cottages at the cross-roads about a mile to the south, to certain farms in Quenington and to troughs in fields.

Coln St. Dennis—Maps: 235; [44]; (36. S.W., 44 N.W., S.W.)

Coln St. Dennis village, which is mainly on the Fullers' Earth, is supplied by wells tapping water, E. G. Hampshire informs me, in his opinion, at about the level of the water in the River Coln. Near Calcott, a hamlet in the parish, is a public well through Great Oolite (probably into the Fullers' Earth), 75 ft. deep. Up the valley north-east of Coln St. Dennis four springs issue from the base of the Great Oolite. Two rams pump water from them up to Goodman's Buildings or 'The Glebe' to the south-east and to Manor Farm and buildings to the north-west. Higher up the valley is Louschill Spring, thrown out by a marly bed in the Great Oolite, but it is not a strong one. In the village is a good spring with an average yield of 8,000 gallons. E. G. Hampshire also informs me that Saltway Farm has a well on the premises, and Calcott Peak Farm a good spring probably also thrown out by a marly bed in the Great Oolite.

Boring at the Manor House.—Made in 1912 for H. S. Beak by, and particulars communicated by, Messrs. Duke and Ockenden, 126, Southwark Street, London, S.E.1.

Surface-Level.—About 400 ft. above O.D.

	Thickness Ft.	Depth Ft.
Dug well.—		
1. Blue clay	60	60
Boring.—		
1a. Blue clay	98	158
2. Yellow clay	3	161
3. Hard stone	47	208
4. Coarse sand	3	211
5. Stone	1	212

Lined with 4½-inch tubes from 115 to 212 ft. down perforated at the bottom.

Yield.—34 hours test pumping gave 300 gallons per hour.

The site of this well and boring is on Fullers' Earth; but a thickness of 161 ft. for Fullers' Earth is more than might have been anticipated. Bed 3 will be Inferior Oolite and presumably beds 4 and 5 belong to the same formation.

Compton Abdale—Maps: 235; [44]; (35 N.E., S.E., 36 N.W.)

Village and parish are dependent on wells and springs, water from the latter being piped in some cases. All wells (up to 30 ft. deep) tap, and all the springs are thrown out by the Fullers' Earth. The Crocodile Spring (558 ft. O.D.) in the village is very copious; E. G. Hampshire informs me that in Oct., 1921, it was yielding approximately 15,000 gallons per 24 hours and that the average flow would be much greater. The village has a supply from this spring which feeds troughs from which the inhabitants obtain water by dipping.

Hill Barn, ¾ mile E. by S. of Compton Abdale Church, has a well on the premises, but it was dry for some time in 1921.

Condicote—Maps: 217; [44]; (21 N.E., S.E.)

The main supply for Condicote village is water probably thrown out by the Marly Beds of the Great Oolite[1] and caught in a well which has a pump and restored Well Cross[2] over it. E. E. Sutton informs me:—"The water was supposed to have healing powers as it runs towards the east. It has never been known to fail, and the well has from 2½ to 3 ft. of water in it."

The overflow from this well is piped to another well some two chains distant, which is fitted with a pump for filling the farm tuns. The supply from this well often gives out when the weather is dry, and its depletion is hastened by the people, when their stores of rain-water have become exhausted, drawing all their water herefrom as long as the supply lasts.

From the spring under the Well Cross run two pipes, one to the Manor Farm; the other, to Cotswold Farm. The first discharges into a 'well' on the lawn, and the second, into a trough; this supply has not been known to fail. The new kitchen at Cotswold Farm is built over the well that formerly furnished the supply.

At Old Hinchwick are two disused wells. Both Old and New Hinchwick have a piped supply from a spring towards the top of the bank 730 yards northward of New Hinchwick just inside Cutsdean parish, Worcestershire. The spring issues through a pipe a little above the reservoir. There were originally two pools at Hinchwick which were puddled to prevent the water from escaping down 'swillies.'

Corse—Maps: 216; [43 N.E.]; (18 N.W., S.W.)

There are some 100 houses in the parish, all dependent on wells, the water in many of which is inadequate and poor in quality.

Cow Honeybourne—Maps: 200; [44, 54 S.E.]; (3 S.W., 7 N.W., N.E.)

The village is on low-lying Lower Lias clay ground and the water-supply is obtained from the Evesham and Pebworth Joint Water Committee.

Cowley—Maps: 234, 235; [44] (34 S.W., S.E., N.E.)

Cowley village is supplied by an undertaking which was provided by Sir James Horlick. The source of supply is a spring situate about half a mile due west of the Church.[3] E. W. Moore, Sanitary Inspector, Cheltenham Rural District Council, informs me that the spring is tapped by a well 3 ft. deep and connected to a reservoir (about 12,000 gallons) close by, whence it

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[1] A useful map showing the distribution of the clay beds in the Oolites of the Condicote district is given by Dr. F. B. A. Welch in his paper on the 'Further Extension of the Great Oolite in the North Cotteswolds,' *Proc. Cotteswold Nat. F.C.*, vol. xxii, pt, 3 for 1926 (1927), p. 222.

[2] *Proc. Cotteswold Nat. F.C.*, vol. xxii pt. 2 for 1925 (1926), fig 1, pl. viii.

[3] Near the "Windmill (Pumping)" on the six-inch map, 34 S.E., but the windmill has been demolished for some years.

gravitates to standposts in the village and is piped to Cowley Manor and some of the houses. The hardness of the water is 25·8°. There is also a supplementary supply from the lake to the south of the Cowley Manor to the reservoir, but it was only necessary to draw on this for two months towards the close of the dry summer of 1921. The lake is fed by a spring issuing from the Cotteswold Sands.

The Air Balloon Inn and three cottages near have a piped supply from a spring thrown out by the Fullers' Earth some 400 yds. to the south by west of the Inn, near The Four Winds. From the cleft west of The Four Winds a strong spring issues for about three months in the year.

The well-known hamlet of Birdlip, perched high on the edge of the Cotteswolds overlooking the Vale of Gloucester, is in three parishes, Cowley, Great Witcombe (one house, the "Black Horse") (Cheltenham R. D.), and Brimpsfield (Cirencester R. D.). It is situate on Inferior Oolite about 200 ft. thick.

The water supply is provided by an undertaking belonging to the Cheltenham and Cirencester Rural District Councils which was constructed about 1884. The source of supply consists of springs (Ridge Well) fed by water that has percolated through the Great Oolite of a small outlier and is thrown out by the Fullers' Earth. The yield of the springs is said to be increased by a strong wind. The water is conducted into two storage reservoirs, one of 48,000 gallons capacity, the other of 30,000 gallons, whence it gravitates to four tanks (each of 3,000 gallons capacity)[1] and taps in Birdlip. Normally about 550 gallons are obtained daily, but in 1921 the springs practically dried up. The water supplied to Birdlip is not filtered, is reported by the analyst to be a "safe spring water" and to have a hardness of 9°. In the L.G.B. Return, 1915 (p. 167) it is said that there is "a slight trace of iron" in the water, but this statement requires confirmation.

There are no true wells in Birdlip.

Cranham—Maps: 234; [44]; (34 S.W., 42 N.W.)

The Overtown Brook has its source high up at Overtown, the springs issuing from the base of the Great Oolite. These springs supply the farm and buildings. Otherwise the water in the parish issues from at or near the base of the Cotteswold Sands. Springs from this horizon are those at Climperwell, up Ladlecombe ("Many Well Springs," etc.), and that situate a little over half a mile east of Cranham Church which contributes its waters to the Overtown Brook.

The greater part of Cranham village is situate on Upper Lias clay. Water is obtained from wells, but a considerable number of the cottagers draw on a spring, thrown out by the Upper Lias clay, on the south-east side of the pit where clay was formerly dug for use at the Pottery.

The springs in Ladlecombe, issuing from the Cotteswold Sands, are numerous, and some of them strong, such as "Many Well Springs"—three in number, issuing at 700 ft. O.D.[2] These springs are collected in a pond in Ladlecombe, whence the water goes to the filter and pumping-station which supplies the Cotswold Sanatorium.

In 1891, when the best means of increasing the water-supply to Gloucester were being considered, among other possible sources attention was given to those of the Painswick and Overtown Streams.[3]

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[1] No. 1 tank, opposite Brimpsfield road; No. 2, west of road; No. 3, George Hotel; No. 4, corner of Black Horse.

[2] The chief spring is depicted in *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 2 for 1925 (1926), pl. ix, fig. 2.

[3] See "Report of W. Fox on the best means of increasing the Water Supply of the City of Gloucester,' 1st June, 1891, p. 7, and Report, 1st July, 1891, p. 8.

Boring about half a mile E.N.E. of Cranham—Made for Mr. Leggatt, Monks Ditch, in 1923 by, and communicated by, Messrs. LeGrand, Sutcliff & Gell, Ltd., Height above O.D. 680 ft.

		Thickness Ft.	Depth Ft.
[Cotteswold Sands]	Loam	19	19
	Mottled sandy clay (water struck)...	10	29
	Blue sandy clay...	17	46
	Hard blue sandy clay	14	60
	Blue sandy clay...	17	77
[Upper Lias]	Lias clay	46	123

Tubes: 17½ ft. of 5 in., top 2½ ft. below surface.
Rest-level.—12 ft. below surface.
Yield.—360 gallons per hour.

Cromhall—Maps: 251; [35]; (55 S.E., 63 N.E., S.E., 64 N.W., S.W.)

The parish is dependent on wells.

Daglingworth—Maps: 235; [34]; (42 S.E., 43 S.W., 50 N.E., 51 N.W.)

E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, informs me that "This village obtains its supply from a spring [thrown out by the Fullers' Earth] on the *west* side of the valley a little above Middle Duntisbourne. The water flows into an underground tank, and thence [through iron pipes] past Hill Farm (Middle Duntisbourne), Duntisbourne Rouse, supplying the part of this village near the church, and on to Daglingworth, where it is laid on to several farms and feeds six standposts (taps) in the village. This supply as at present existing was taken over by the Council on 6th June, 1888.

"Grove Hill is supplied by a well [? in Forest Marble] fitted with a pump. There are some six cottages here.

"At Daglingworth Place there is a bore-hole, 127 ft. deep in Great Oolite [tapping water held up by the subjacent Fullers' Earth]. The supply is adequate."

Deerhurst—Maps: 216; [44]; (18 N.E., S.E., 19 N.W., S.W.)

Apperley Court is supplied with Cheltenham Corporation water, but otherwise the parish—which is for the most part on Keuper Marl—is dependent on wells, the water in which is adequate in quantity and, on the whole, satisfactory as regards quality. Many of the wells are deep.

Regarding Apperley Court, C. Strickland informs me that before Cheltenham Corporation water was laid on, his house was supplied from a well about 120 ft. deep in Keuper Marl.

Didbrook—Maps: 217; [44]; (13 S.E., 20 N.E.)

The upper part of Didbrook is supplied by a spring issuing from at or near the base of the Sandy Beds of the Middle Lias in a thicket in the field called 'Leasow,' below Hailes Wood. The spring water is led into a chamber, thence to a small reservoir, whence it is piped to the village. The bottom part of the village is supplied from the Cowsmoor Spring.

Didmarton—Maps: 251; [35]; (65 N.W., S.W., N.E., S.E.)

The village of Didmarton is supplied by the West Gloucestershire Water Company.

Joyce Pool is marked on the Geological Survey Map as "a source of the [Bristol] Avon." T. V. H. Davison informed me that it is always full of water.

Dodington—Maps: 251, 265; [35]; (69 S.W., S.E., 73 N.W., N.E.)

Dodington village, on the Middle Lias, is served by the West Gloucestershire Water Company.

The Seven Springs are the source of the River (Bristol) Frome. They rise in a valley at the south-eastern corner of Dodington Park and issue from amid Fullers' Earth below a retaining wall beneath the Park wall on the west side of the Bath road. The Fullers' Earth has slipped down the valley-sides in many places, obscuring the outcrops of the Inferior Oolite and Sands, and several springs make their appearance at lower levels (500 ft. above O.D.).

Donnington—Maps: 217; [44]; (21 S.E., 22 N.W., N.E., S.W.)

Donnington is supplied by wells fitted with pumps and a spring (not very constant) in the middle of the village, which is caught in a reservoir and feeds a trough, the overflow of which is piped to one of the farms. Lower down the valley, at the head of which is this spring, a strong spring appears and runs to waste. The Manor House is supplied from the main to Moreton in Marsh.

The well below the windmill pump at Duncombe House was sunk through a trace of Cotteswold Sands into Upper Lias clay.

The fine pond at Donnington Mill is situate in this parish. Following the water up the valley a place is reached where near Waterhead Barn the water makes its appearance in a valley usually dry for miles above. A little to the south-east of Waterhead Barn is the wind-pump which raises water to the reservoir at Flagstone (p. 166): a little to the north, in Longborough parish, that which lifts up the supply for Banks Fee (p. 112).

Dorsington—Maps: 200; [54 S.E.]; (3 N.E.)

This parish, on the Lower Lias, is dependent on wells.

Dowdeswell—Maps: 217, 235; [44]; (27 S.W., S.E., 35 N.W.)

The source of River Chelt is situate in the bank to the south and above the western entrance to the tunnel in the field on the west side of the road opposite the avenue up which is a view of Sandywell Park. The water flows into an old brick chamber from which it was formerly pumped to supply Sandywell Park, but now flows down the hill-side past Chelt Spring Cottage.

Dowdeswell Reservoir (Cheltenham Corporation Water Works) is formed by the impounding of the head-waters of the Chelt (p. 205).

At Lower Dowdeswell, the Rectory, a farm and the houses lower down have a piped supply from a tank opposite the church which is supplied by the well or reservoir near the Camp.

Upper Dowdeswell is supplied from a spring thrown out by the Upper Lias in the valley below. The water is pumped up to a well (reservoir) near the Camp, whence it gravitates to the Manor House, Manor Cottages, Park Villas and a standpost in a stone erection. At the Manor House is also a well.

The greater part of Andoversford is supplied by a one-inch pipe, from a trough at Ossage Farm, which is fed by a spring thrown out by the Upper Lias clay. The G.W.R. Station is supplied from the Coln.

A well at Cold Comfort is 174 ft. deep and on 4th August, 1920, had 4 ft. of water in it.

Near the south-western extremity of the parish near Needlehole is one of the few swallow-holes that I have noticed in the Cotteswold Hills (p. 27).

Down Ampney—Maps: 252; [34]; (52 S.W., 60 N.W., N.E., S.W.)

The village is on gravel and is dependent on wells, 8 to 14 ft. deep, sunk in this deposit. Some of the wells failed in 1921, mostly at the west end of the

village, while those on the north-east side gave a fair supply. The well at the School House is 8ft. 6 in. deep and on 7th August, 1922, had 7 ft. 6 in. of water in it. Down Ampney House is supplied from a well in the gravel, 8 ft. deep, with 3 to 4 ft. of water in it. The rest-level of the water fluctuates according to the condition of the adjoining brook. The water is pumped to a tank (1,000 gallons) in the roof of the house and to a tank (800 gallons) at the Home Farm. A spring at The Oaks, issuing from gravel on Oxford Clay, never fails. There is also a well (about 8 ft.) for supplying the farm and two cottages. The Rev. R. Lingard Simkin informed me that a well in a hedge in a field near The Oaks Cottages is known as St. Augustine's Well, and is held by some authorities to have been the spot where St. Augustine met the Welsh Bishops. The cottages at The Fens are supplied from a well (about 8 ft. deep), and there is also a spring used for watering the cattle. Castle Hill Farm is supplied from a strong perennial spring near The Fens, the water of which is collected into a tank and raised about 60 ft. by ram to the farm, which is on Oxford Clay.

Broadway Farm is situate to the N.N.E. of Down Ampney Church. E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, informs me that "A boring (6-inch) was made towards the end of 1921 here to over 215 ft. in depth in Oxford Clay without any result. In addition to this a boring was made (about 1902) for water at Castle Hill in similar clay to a depth of 120 ft., but no water was found, although a 'Dowser' said it would be encountered at 35 ft."

Down Hatherley—Maps: 216; [44]; (25 N.E., 26 N.W.)

This parish is on the Lower Lias on the surface of which is locally some superficial sand and gravel.

There are some 40 houses in the parish all dependent on wells. Thus one just north of the Church is 20 ft. deep in Lower Lias clay with water standing at 6 ft. 6 in. below the surface of the ground.

R. C. S. Walters informs me that "One mile west of the Church and south of the road to Twigworth, on the allotments, is 6 ft. of gravel (oolitic—rather angular) and sand, in which there have been some recent diggings for new bungalows, etc. Two new wells penetrated 6 ft. of sand and gravel and 3 ft. of Lower Lias clay and gave a reliable supply of water 6 ft. deep."

The Village Well, fitted with a pump, is about 50 ft. deep in Lower Lias clay.[1]

Boring at Woods Farm.—½ mile E.N.E. of Down Hatherley Church.

Lower Lias clay with an occasional limestone-bed... 60 ft.

(Analysis, p. 258).

Doynton—Maps: 265; [35]; (73 S.W., S.E., 77 N.W.)

Doynton village is supplied by the West Gloucestershire Water Company. Formerly it was dependent on wells sunk in the Lower Lias.

Driffield—Maps: 252; [34]; (51 S.E., 52 S.W., 59 N.E., 60 N.W.)

The village is on Cornbrash and is dependent on shallow wells up to 20 ft. in depth. These yield none too satisfactory a supply: the most satisfactory well is that situate in a meadow to the east of the Church. It is 14 ft. deep, normally has about 9 ft. of water in it, but it went dry in 1921. The village is situate too near the bottom of the Cornbrash for the shallow wells in that formation to yield a constant supply. At the shepherd's cottage, near Fosse

[1] *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 3, 1914, p. 248.

Farm, on the other hand, is a well 20 ft. deep (sunk in 1918) through the bottom portion of the Oxfordian into the Cornbrash which gives a good supply.

Dumbleton—Maps: 217; [44]; (13 N.W., N.E.)

Dumbleton village, on the Lower Lias, is supplied with water from the hill by undertakings provided by Mrs. Eyres Monsell. The water is laid on to the houses in nearly all instances, but there are in addition three standposts in the village.

J. M. Pyke-Nott, Agent to the Dumbleton Estate, has furnished me with the following particulars: (1) Hollow Spring. Situate in Hollow's field, under the new covert planted on Big Hill. The water is very hard, comes out of calcareous rock and is not filtered. (2) Red Water Spring. Situate at bottom of covert on Chair Hill. The water is red (very chalybeate), comes out of ferruginous rock [Marlstone], and is filtered. These two springs feed by pipe Leyfield Farm, Cottons Farm, Mill House and Cottages, Lanes Farm and Little Cheltenham (cottages). (3) The Chair Spring. Situate on Chair Hill just below the covert. This water is slightly calcareous and also chalybeate. It is filtered and comes out of the Marlstone. This spring feeds Dumbleton Hall and the top part of Dumbleton village. (4) Bradley Spring. Situate in the hollow between the Big Wood and the Top Hill in a field known as 'Lime Field.' This water is the least hard of all the supplies. It is not filtered. This spring supplies Dumbleton Hall (by gravity), Dumbleton village and Dumbleton Hall lake. (5) Oxhill Spring. Situate in Oxhill Covert near the bottom of same. The water is very hard and comes out of limestone. It is not filtered. I have not opened this spring to its source, but from observation I am strongly of opinion that it comes from limestone as stated. Limestone is known in this neighbourhood as there was a lime-kiln some time ago quite close. This spring supplies Dumbleton Hall, bottom part of village and Brickyard Farm. In the cases where the spring waters are filtered the filters consist of long brick chambers filled with pebbles which are periodically cleaned. They are filtered because of their chalybeate nature. There are no wells except rain-water ones.

Duntisbourne Abbots—Maps: 234, 235; [34, 44]; (42 N.E., S.E., 43 N.W., S.W.)

This parish is for the most part on Great Oolite, but Fullers' Earth crops out from beneath it in the valley in which the village is situated.

The greater part of the village is supplied by a strong perennial spring below the Church, which overflows to a horse-trough and then runs to waste into the brook. A well between the Church and Gloucester road is 25 ft. deep in Great Oolite, yields a good supply and provides four cottages with water. South-east of the village, by Belcher's, is a spring that never fails. A spring on the east side of the valley (at the 'u' in Nutbean Farm on the Geological Survey map, Sheet 44), on a line of fault, is collected into an underground tank (about 1,000 gallons) from which it gravitates to the farm house of Duntisbourne Leer and two taps. Another spring near by supplies several houses and is laid on to a tap by the road-side for the use of some cottages. Nutbean Farm has spring water pumped to it by a ram. Jackbarrow Farm has a well, about 100 ft. deep in Great Oolite, in which there is usually about 3 ft. of water, flowing, E. G. Mathews informs me, south-eastward. The water is raised by a windmill to a tank (3,000 gallons) from which it gravitates to the farm. Duntisbourne House is supplied from a strong spring in the Frome Valley below, the water of which is forced up by ram to an underground tank.

Boring at Windmill Cottage.—Made, 1925, and communicated by Messrs. Ockenden and Smith. Bored 72 ft.

	Thickness Ft.	Depth Ft.
Dug well	56	56
Grey clay	2	58
Sandstone and mixture	4	62
Sandstone	3½	65½
Hard rock stone	12	77½
Clay and stone mixture	6½	84
Blue clay	5	89
Grey loam	5	94
Hard loam stone	4½	98½
Hard blue rock	1½	100
Blue rock	1	101
Blue loam	2	103
Loam and stone, with thin veins of sand ...	5	108
Hard grey clay mixture	2	110
Grey loam and stone	7	117
Grey loam and stone, with 1 ft. of loose gravel and blue clay	11	128

Rest level.—101 ft. down.

Yield.—5 hrs. pumping test gave 900 gallons per hour.

Duntisbourne Rouse—Maps: 235; [34, 44]; (42 S.E., 43 S.W., 50 N.E.)

The part of the village of Duntisbourne Rouse near the Church is supplied from the Daglingworth main (p. 80): Hill Farm (Middle Duntisbourne), fields and cottages from a spring thrown out by the Fullers' Earth on the east side of the stream, almost opposite the source of the Daglingworth supply.

Dursley—Maps: 251; [35]; (48 S.E., 56 N.E.)

The public supply (Dursley R.D.C.)[1] is obtained from a well, 62 ft. deep, 6 ft. in diameter, and cemented for a depth of 44 ft., through Upper Lias clay into Marlstone, at the Council's Pumping Station about ⅜ of a mile east-south-eastward of Dursley Church. H. D. A. Humphrey, Consulting Engineer, Stonehouse, states (31st Dec., 1926): "At the present time the water in the well is not lowered at all by pumping, the flow into the well being apparently greater than 7,000 gallons per hour [pumped], as we know where the overflow is and this continues running while pumping. In dry weather the overflow ceases when the pumps are working, and the water is lowered about 5 feet in the well after 12 hours pumping but recovers normal about 1 hour after the pumps are stopped."

The water (analysis, p. 258) is pumped to a reservoir (approximately 90,000 gallons) a little under half a mile to the south-west by west, on the west side of the road from Woodmancote to Whiteway Cottage.

At Poole Cottages is a well, 34 ft. deep, with usually 10 ft. of water in it, which used to supply thirteen cottages. The undertaking was acquired by the Council in 1911, and water from the main was laid on to the cottages and the well abandoned.

Between the Dursley Secondary School and the railway some water issues from well-separated sandy limestones (on an average 7 ins. thick) in clay belonging to the Sandy Beds of the Middle Lias. It is obvious from the irregular nature of the ground in the lower portion of the field that there has been considerable slipping of the clay owing to the effluent seepage of water from the sandy limestones. Owing to this slipping the outburst of water as well-defined springs has been obscured and matters have been complicated by drains laid no doubt with a view to rendering swampy ground more suitable

[1] Richardson, L., 'Dursley Waterworks,' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 3 for 1926 (1927), pp. 265, 266.

for pasture land. Water collected from the field discharges from two pipes alongside the railway, but the total amount that could be collected from the field would be inadequate and unreliable for even a small public supply.

There are a number of springs running to waste into the River Ewelme or Cam—Caswell Stream, close to the Pumping Station; at Rockstowes; Wresden Farm; and Ferney Hill. That at the last locality is a petrifying spring and has made an extensive deposit of tufa.[1]

The springs known as Broadwell[2] are situate in the town near the Church and discharge into the Cam. Their waters have made a considerable deposit of tufa, or, as it is locally called, 'Puff Stone.'

Dymock—Maps: 216; [43 N.E.]; (9 S.E., 10 N.W., S.W., S.E., 16 N.E., 17 N.W., N.E.)

Dymock village is situate on the Old Red Sandstone and is dependent on wells from 10 to 60 ft. deep (analysis, p. 259). During the summer of 1921 many went dry, but generally the supply is good and adequate. A. E. W. Paine informs me that the well in the Old Red Sandstone at 'Swords' ($1\frac{3}{4}$ miles N. by W. of Dymock) was over 40 ft. deep and that the water was good, but always very sparkling, and never failed.

Some 24 cottages and 2 farms at Bromsberrow Heath, which is in Dymock parish, are supplied from the Malvern Urban District Council's Pumping Station. Sir Arthur Anstice, K.C.B., informed me on 4th June, 1921, that he did not know the depth of his well (in the Old Red Sandstone) but the water had not failed during the sixteen years he had been at The Old Grange. A number of springs issue from the Old Red Sandstone in Dymock Wood.

The dip of the New Red Sandstone varies between east and south, the prevalent dip being probably south-easterly. The Coal Measures doubtless underlie the sandstones in the southern portion of this eastern part of the parish and hold up water, causing saturation of the sandstones below a certain level. The sandstones are full of water which is drawn on by the Malvern Urban District Council's Waterworks at Grove Farm, Bromsberrow, immediately to the north of the parish boundary, and by the Gloucester Corporation's Waterworks at Ketford immediately to the south of the parish boundary. Pumping operations lowered the water-levels in the wells some 4 or 5 ft. within a half mile radius of the Pumping Station of the Malvern U.D.C., so the cottages (43) at Bromsberrow Heath are supplied in bulk by that Council through a pipe laid and maintained by the Newent R.D.C. Particulars of a number of wells in this parish are given under Bromsberrow. An analysis of water from a well in the Keuper Sandstone at Lintridge is given on p. 259.

Dyrham-and-Hinton—Maps: 265; [35]; (73 N.W., N.E., S.W., S.E.)

Dyrham village is supplied from a reservoir at the foot of Sands Hill (near the P.O. on the six-inch map 73 S.E., $\frac{1}{4}$ mile S.W. by S. of the Church) which is fed by springs. There are a few wells in the Sandy Beds of the Middle Lias and the top portion of the Lower Lias, but they are not deep.

Dyrham Park is supplied by a reservoir in the Park ($\frac{1}{8}$ mile east of the house) which is fed by springs that rise in the Park (issuing, presumably, from the Cotteswold Sands). The drinking water comes from a separate spring in the Park, which has never failed, but it has been impossible to locate it. The drought of 1921 affected the supply to the house, to a certain extent, but there was always a sufficiency of water.

East Dean—Maps: 215, 233, 234; [35, 43 S.E., S.W.]; (23, 31, 39)

As in the case of West Dean there are wells in this parish, but many have been drained by past and present mining operations. The problem of supply

[1] Richardson, L., 'The Dursley Tufa,' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 3 for 1926 (1927), pp. 267-270.

[2] *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 3 for 1926 (1927), pl. xxvi, fig. 2.

has been solved, however, by the Cinderford Waterworks, which derive the bulk of their water from the Old Red Sandstone outside the basin.

Cinderford Waterworks.[1]—East Dean and United Parishes Rural District Council.

Powers.—Incorporated Waterworks Clauses of the P.H.A. 1875.

Area supplied.—Township of East Dean (see below) and about 45 houses in the parishes of Little Dean and Ruardean which are on the fringe of the East Dean border.

Sources of Supply.—(*a*) Heading, 400 yds. long (varies from 3 ft. high by 2 ft. wide where driven in loose ground to 6 ft. high by 4 ft. wide where driven in solid rock) driven from Greenbottom through the top beds of the Old Red Sandstone, Lower Limestone Shales and into the Carboniferous Limestone, to Beech Pit Shaft (182 ft. deep). (*b*) Well, 120 ft. deep, 6 ft. in diameter (in the clear), in Old Red Sandstone at the Pumping Station, Greenbottom. The bottom of the well is about 125 ft. vertical below the outlet of the heading (*a*).

Average daily quantity of water obtained during dry weather from :—(*a*) Heading.—At least 100,000 gallons a day ; (*b*) Well.—200,000 gallons a day. Analysis, p. 260. Effect of drought of 1921, nil. The depth from the surface to the rest-level of the water in the well during continued wet weather is 27 ft. ; in dry weather, 45 ft. When pumping at about 10,000 gallons per hour the rest-level falls to 65 ft. below surface-level.

Works.—No filtration.

Impounding reservoir (170,000 gallons) near the Pumping Station ; Pumping Station (438 ft. above O.D.) in Greenbottom ;

Service-reservoirs.—(*a*) Little Dean Hill (270,000 gallons) ; (*b*) Ruardean Hill (100,000 gallons). Pressure sufficient.

These Waterworks owe their position to the fact that there was here the outlet of a heading which had been driven by Messrs. Henry Crawshay & Co. through the topmost beds of the Old Red Sandstone, Lower Limestone Shales (120 ft), and Carboniferous Limestone to Beech Pit Shaft (from which there is a cut-out driven 50 to 60 yds. in a north-westerly direction to a scowle or iron-mine churn), with the object of draining off the water that got into the workings.

W. Whitehouse, Surveyor and Waterworks Engineer to the East Dean and United Parishes Rural District Council says :—" This heading is about 400 yds. long and from what can be gathered from the information handed down by the workmen, considerable trouble was experienced in performing the work. When about 100 yds. of the heading had been driven, almost through the [Old Red] sandstone, the workmen had to cut through, for a considerable distance, a bed of conglomerate or what is locally known as pudding-stone. . . . This rock yielded water so rapidly that, to use the words of the workmen, it flew out as though shot from a riddle, and the work of driving the heading had to be abandoned for a time. This work was subsequently taken in hand and completed."[2]

As the volume of water issuing from the heading was considerable and the quality good the construction of the Waterworks was commenced about 1870 and completed about the end of the year 1874. In 1884, to meet the increasing demand for water, an impounding reservoir, with a capacity of 225,000 gallons and covered with galvanized iron, was constructed near the Pumping Station to store the water which flowed from the heading during the night and at periods when pumping was not in progress. In 1896 the service-reservoir was made 5 ft. deeper and covered to prevent deterioration of the water.

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[1] Described in detail by Wm. Whitehouse and L. Richardson, *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 3 for 1923 (1924), pp. 223-227 and coloured section.

[2] *Contractor's Record and Municipal Engineering*, vol. iv, No. 4, Jan. 12, 1910, p. 88.

In 1903 the heading was examined, cleaned out and repaired, and resulted in an addition to the supply to the extent of at least 25 per cent. In 1907, owing to the continued growth of the demand for water, it was decided to provide an additional supply. It had been noticed when cleaning out the heading that much water 'boiled up' from the Old Red Sandstone beds in the floor of the heading, and this fact combined with others known by Wm. Whitehouse led to the sinking of a well. "The dip of the strata," wrote Whitehouse, "also assured us that in sinking a shaft we should not interfere with our existing supply." The well, 120 ft. deep, was commenced in the spring of 1907, and finished towards the close of the summer of 1908. In December, 1914, Whitehouse submitted a scheme for the "Proposed Extension of Cinderford Waterworks, to the north-west portion of the Township of East Dean, for the Rural District Council of East Dean and United Parishes." Its execution was delayed by the War, but is now (1923) being proceeded with. It includes a ferro-concrete, covered service reservoir (100,000 gallons, divided into two chambers) by the flagstaff at Ruardean Hill (the highest point in the Forest) where it dominates every part of the Township of East Dean, and the necessary mains. When these extensions are completed the number of houses supplied will be 3,000 and the population 13,000. The number not so supplied will be about 450, and the population about 2,000. The bulk of the 450 houses are spread over Ayleford, Soudley, Brain's Green and Viney Hill, and are included in the second portion of the scheme extending from the south end of Ruspidge to Viney Hill, and would absorb, say 350 of the 450 houses not supplied. The remaining 100 houses are in the neighbourhood of Pope's Hill and Plump Hill, and the latter places could be brought within the present works by extending the existing mains at Harrow Hill, Drybrook. Pope's Hill could be supplied by an extension from Little Dean Hill. A few houses are scattered along the border of the Township of East Dean, in isolated positions, but, generally speaking, the scheme outlined covers the whole.

An excellent spring issues from the pudding-stone (quartz-conglomerate) of the Upper Series of the Old Red Sandstone between East Dean and Cornage Wood. A little to the south-west of it is Stackpage Well. This well originally contained an excellent supply, but went dry some two years ago, owing, so local miners say, to a slight tremor or earthquake. The heading driven into the Old Red Sandstone by the Chaston Syndicate in search of gold is now being continued to the Wigpool Iron Pit to develop the iron ore. L. G. Lyne, Sanitary Inspector, East Dean and United Parishes Rural District Council, informs me that four wells in the vicinity of this work suddenly went dry.

This locality was visited by Dr. T. Wright in his quest for additional sources of supply for Cheltenham. He notes Stackpage (he calls it 'Stocknage') and "another spring, of like character and yield" which "arises about half a mile further, the same height on the hill. The spring yielded by measurement about 20 gallons per minute, ..." He concluded that "The small yield of the springs and their distance from Cheltenham are the objections, unless a larger supply could be found to increase the amount. The water is pure, but rather hard, it contains in two samples, 16 and 22 grains of calcareous matter in the gallon, with no trace of organic matter."[1]

The Wigpool Iron Pit and the stream of water that runs from the northern end of the railway-tunnel a mile north of Drybrook, were both examined by Wm. Fox in connexion with the investigation for augmenting the water-supply of Gloucester, but were considered insufficient.[2]

At Soudley, in Sutton Bottom, and in Sneyd Wood in particular, some good springs issue from the Upper Series of the Old Red Sandstone and water therefrom could be forced by ram over the hill to augment the supply to Newnham.

[1] Wright, T., and D. J. Humphris, "Report on the Sources of an Additional Supply of Water to the Town of Cheltenham," Cheltenham, 1863, p. 23.

[2] "Report on the best means of increasing the Water Supply of the City of Gloucester." (1st June, 1891), p. 11.

Wm. Fox stated in 1891 :—" From the Shakemantle iron mine near Ruspidge, belonging to H. Crawshay & Co., Limited, a large quantity of water is constantly being pumped, varying, I am informed, from 60,000 gallons per hour to over 100,000 gallons per hour. This water comes from the [Carboniferous] Limestone underlying the coal measures. . . ."[1]

Dr. T. F. Sibly states :—" Mean water-level falls steadily southwards from Wigpool Pit, where it stands about 460 ft. above O.D. to the Shakemantle Pit in the Soudley Valley, where it stands some 200 ft. above O.D.[2]

East of Chudleigh Holes, between the stream and the road, but near to the stream, at the place locally spoken of as ' Silly Point,' is a strong spring the water feeding which, Wm. Whitehouse informs me, comes from the Carboniferous Limestone. It is marked on the 6-inch map, sheet 39 N.E. : it is the ' Spr.' near ' Chudleigh Holes.' Wm. Whitehouse has gauged the spring and ascertained a yield of at least 500,000 gallons a day. He has had a dipping well made for the use of the people at Upper Soudley.

Blakeney Hill is supplied from a spring (Old Woman's Well) issuing from the Old Red Sandstone by the side of Blackpool Brook in Blakeney Hill Wood South. The water is raised by pumps, operated by a water-wheel, to a reservoir (14,000 gallons) at Blakeney Hill, from which it is laid on to houses at Blakeney Hill and in Old Furnace Bottom. The average daily quantity of water obtained is 9,000 gallons and a further 5,000 gallons per day is available, if required.

Viney Hill is dependent on rainwater storage and a few wells.

At Plump Hill, six standposts down Jubilee Road (one side of which is in East Dean and the other side in Abinghall parish) are supplied from a reservoir (1,500 gallons) just below the upper of two springs north-west of the Rookery, Horsepool Bottom (⅔ mile S.W. by S. of Abinghall). The spring issues from the pudding-stone (quartz-conglomerate) of the Upper Series of the Old Red Sandstone. The average daily quantity of water obtained from this spring is 600 gallons and a further 100 gallons daily is available if required.

At Joys Green a standpost by the roadside between the Post Office and the Readings has water, which runs out of an old level known as ' Scott's Level,' forced to it by a ram.

St. Anthony's Well spring issues from the group of quartz-conglomerates at the base of the Upper Series of the Old Red Sandstone at the foot of a steep bank into a stone-slab-covered dip. From the dip it is piped into a basin measuring approximately 11 ft. 6 in. by 8 ft. by 5 ft., in which there is usually about 3 ft. of water. Stone steps lead down into the pool on one side. The water leaves the basin by a 6-inch pipe to originate the Westbury Brook, which, at the old Gunn's Mills, is impounded to form the mill-pond. On 8th Oct., 1922, the water was discharging through the outlet pipe from the basin at the rate of about 200,000 gallons per day ; and at the outlet from the mill-pond, at about 300,000 gallons per day.

St. Anthony's Well is a Holy Well (p. 44), and the water was celebrated " as a certain remedy for all diseases of the skin, and, it is said, has been known to cure leprosy."[3]

Eastington (near Northleach)—Maps : 235 ; [44] ; (36 N.W., N.E., S.W., S.E., 44 N.W., N.E.)

The little village of Eastington is situate astride the Leach. Its supply is drawn from a tap in the village which is fed by water derived from a heading, driven in about the junction of the Great Oolite and Fullers' Earth, and catch

[1] " Report on the best means of increasing the Water Supply of the City of Gloucester." (1st June, 1891), p. 11.

[2] ' Special Reports on the Mineral Resources of Great Britain ' (*Mem. Geol. Surv.*), vol. x, (Iron Ores (contd.), The Haematites of the Forest of Dean, etc.), 1919, p. 23.

[3] *Trans. Bristol and Glos. Arch. Soc.*, vol. vi, 1881-82, p. 265. See also *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 3 for 1923, 1924, p. 196.

well in the east side of the Leach valley $\frac{1}{6}$ mile to the north. This supply belongs to the Parish Council. The heading is about 18 ft. long, $6\frac{1}{2}$ ft. high, and 2 ft. wide. The normal yield is 600 gallons a day, but in Aug., 1921, it was barely 150 gallons.

Lower End Farm and buildings, Lord Sherborne's property, are supplied from the Wellings Spring, *via* a reservoir situate $\frac{2}{3}$ mile N. by E. of Lower End.

Upper End Top Farm and Manor House, Cats Abbey Farm and Cottage Farm are supplied from springs thrown out by the Fullers' Earth at Upper End. There are two rams: the upper ram pumps water through a one-inch pipe to a 1,000 gallon tank in the barn: the lower ram—which is worked by water from the River Leach—the surplus water from the upper ram to a reservoir, which is 142 ft. rise on the delivery pipe, at Helen's Ditch, $\frac{2}{3}$ mile away in a westerly direction, from which the water gravitates to Cats Abbey and Cottage Farms. Broadfield Farm and Cottages are supplied by a spring issuing from the Great Oolite at Trowelhead Cottages from which water is forced up by a ram. Winterwell Farm has a well on the premises: Winterwell Barn is supplied from The Wellings Spring. The Fever Hospital on Northleach Downs is supplied from a well 84 ft. deep (through Great Oolite and ? Fullers' Earth to Inferior Oolite) and 65 ft. from the surface to the water. The supply is constant.

The Seven Springs or 'Wellings' are described under Northleach (p. 126).

Boring at New Barn.—Information supplied by W. H. Hartwell.

[Through Great Oolite and ? Fullers' Earth into Inferior Oolite] ... ... 110 ft.

85 ft. to pumps: 105 ft. to water-level.

Water hand pumped. Supplies farm and cottages. Supply adequate.

Eastington (near Stroud)—Maps: 234; [43 S.E., 35]; (40 S.E., 41 S.W., 48 N.E., 49 N.W.)

The village is partly on Lower Lias clay and partly on sand and gravel.

The greater part of the parish is supplied by the Stroud Water Company. Such wells as are in use are from 14 to 25 ft. deep and yield, so A. J. Mugliston informs me, a satisfactory supply of water both as regards quantity and quality.

Mr. Mugliston informs me that borings have been made in the parish in search of water, but, as might be expected, were not successful.

Eastleach Martin—Maps: 235; [34, 44]; (45 S.W, 53 N.W., N.E.)

The tiny village of Eastleach Martin is supplied from the same source as Eastleach Turville.

The hamlet of Fyfield is dependent on wells sunk in the Cornbrash, some dip, others fitted with pumps. One well, which was examined, is 10 ft. deep and on 23rd Aug., 1922, had 6 ft. of water in it. Some wells went dry in 1921.

Eastleach Turville—Maps: 235; [34, 44]; (45 N.W., S.W., 53 N.W.)

The western and higher part of the village is on the Forest Marble, the eastern and lower, on the banks of the Leach, on the Great Oolite.

The village is for the most part supplied from a well close to the east side of the Leach between the Church and Rectory in Eastleach Martin parish. The well is said to be in front of the door of the Pump House and to tap a spring. The water is pumped from the well to a reservoir on the opposite side of the valley in Eastleach Turville village, from which it gravitates to standposts. There is also a Fountain near the brook from which a copious supply of water is discharged except in dry weather, and there are some wells in the village.

Manor Farm is supplied from a borehole under the building of 'The Lannocks,' in the Leach valley above Sheep Bridge. The water is pumped. Water from the well also supplies the open reservoir and tank which is used for watering the cattle in the fields in 'The Lannocks' Bottom.

Boring above Sheepbridge.—Made by H. J. Godwin, Quenington, for Executors of the Hatherop Estate in July, 1921. Particulars communicated by E. W. Radway, Agent to the Hatherop Estate.

Sunk, 12 ft. : bored 154 ft.

		Thickness Ft.	Depth Ft.
[Great Oolite and "Passage Beds"]	Brown marl and stone on edge	23	23
	Blue marl	3	26
	White limestone	9	35
	Blue stone	4	39
	White limestone	15	54
	Blue stone	1	55
	White limestone	19	74
	Blue marl	6	80
	Blue stone and thin clay beds	18	98
[Fullers' Earth]	Blue clay	20	118
[Inferior Oolite]	Blue stone (hard)	4	122
	White soft stone (freestone) water	8	130
	Blue stone	35	165
[Upper Lias]	Blue clay	1	166

Lined to a depth of 118 ft. 3 in. with 5-inch diameter pipe. Rest-level of water.—21 ft. below surface. Yield.—Tested at 900 and 700 gallons per hour for 9 hours.

Ebrington—Maps: 200, 217; [44]; (8 N.W., S.W.)

At or near the junction of the Sandy Beds of the Middle Lias with the Lower Lias is an important water-horizon in this parish. The spring issuing from this horizon at The Grove, a third of a mile distant from Ebrington Church in an easterly direction furnishes a supply in bulk to Shipston-on-Stour, Worcs. The late Dr. G. Findlay informed me that the yield of the spring is over 100,000 gallons a day: at the Inquiry into the Moreton in Marsh water-supply held on 21st June, 1903, it was stated (Report, p. 26) to be from 120,000 to 180,000 gallons a day. The average daily quantity of water supplied to Shipston is 40,000 gallons (analysis, p. 260).

The village of Ebrington, on the Marlstone, is dependent on wells, from 18 to 40 ft. deep, and springs.

Edgeworth—Maps: 234, 235; [34]; (42 S.E., 50 N.E.)

E. J. Mathews, Sanitary Inspector, Cirencester Rural District, informs me:—"A spring at Jack's Acre, north of the village [which is on the basement beds of the Great Oolite] supplies water to an iron tank on tower (2,500 gallons), from which it gravitates to some new cottages and is distributed all over the farm. The overflow from this spring supplies Valley Farm. Water from a spring near the Manor House is forced into an underground reservoir (6,000 gallons) to the west of the house, from which it gravitates to the house, North Farm, Rectory, The Closes and to various cottages. At Monsols Cottages is a weak spring, but it never fails."

In Henwood, north of Henwood Mill, on the River Frome, is an interesting 'petrifying spring,' the water of which is thrown out from the base of the Great Oolite by the Fullers' Earth clay. The steep valley side between the outburst of the spring and the juvenile River Frome is caked with a deposit of carbonate of lime (calcareous tufa). Samples of the water and tufa

have been analysed by Cecil Duncan.[1] The amount of carbonate of lime in the water was found to be only 19 parts per 100,000, so that the water was of a total hardness of 12·3° (Clark), of which 10° were temporary hardness. About 85 per cent. of the tufa was carbonate of lime, and the remaining (about) 15 per cent., moisture, organic matter, sand, and other mineral matter.

The interesting fact is that many spring waters are harder than these petrifying waters, but they do not petrify. The underground waters feeding such springs as in Henwood are probably under pressure and colder than the atmosphere. Reduction of pressure as the water emerges and increase in its temperature will tend to decompose the soluble bicarbonate into insoluble calcium carbonate (chalk).

It appears that the carbonate of lime is very loosely held in solution in the spring water underground by the additional amount of carbon dioxide necessary to keep it in the form of the soluble bicarbonate, and that simple shaking, such as the water receives in coursing down a hill side, over stones, or by interruption by twigs, etc., is sufficient to effect the separation of the soluble bicarbonate and the deposition of the insoluble carbonate of lime. (Analysis, p. 260.)

Elberton—Maps: 250; [35]; (62 N.E., S.E., 63 N.W., S.W.)

The parish is dependent on wells, but the supply is often insufficient. In the village, which is on Carboniferous Limestone, is a pump belonging to the Thornbury Rural District Council, but the supply of water ran rather short in 1921.

Elkstone—Maps: 235; [44]; (34 S.E., 35 S.W., 42 N.E., 43 N.W.)

Elkstone is dependent on wells and springs. A weak spring near the School supplies several houses.

At Coombend there are two springs thrown out by the Fullers' Earth, water from which is forced by rams to storage tanks at Coombend House and at Masons Arms, Beech Pike, in Winstone parish.

Elmore—Maps: 234; [43 S.E.]; (32 N.E., S.E., 33 N.W., S.W.)

The 82 houses in the parish are dependent on wells from 16 to 20 ft. deep.

Elmstone Hardwicke—Maps: 216; [44]; (19 N.W., S.W.)

The parish is on Lower Lias with locally traces of gravel and is dependent on wells. The Village Well, about 100 yds. south-west of Elmstone Church, is about 20 ft. deep and yields a good supply.

At Potters House, near the Church, a well sunk in 1922 is 22 ft. deep in Lower Lias clay with small cement-stones. A seam of 'sandy clay' (? decomposed limestone bed) is said to have been struck at the bottom. The water stood at 15 ft. from the surface, was very clear, but tasted slightly saline.

The well at Colman's Farm is 25 to 30 ft. deep and is said to have been sunk in :—

	Ft.
Clay	20
Gravel	3
Clay	5 to 7

It yields an unfailing supply. It may be that there are pockets and veins of gravel in the Lower Lias of this neighbourhood as is the case in many others in the Vale.

[1] Duncan, C., and L. Richardson, 'Henwood Petrifying Spring, Edgeworth.' *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 1 for 1924, 1925, pp. 55, 56.

The village of Hardwicke obtains its water from a Parish Well. R. C. S. Walters informs me :—" This well, which is opposite the Post Office, is known locally as ' Mitchell's Well.' It is 11 ft. deep, brick steined, and towards the end of June, 1922, had 9 ft. of water in it. It is said to be supplied by a spring, probably water from the neighbourhood of a limestone-bed or a vein or pocket of sand or gravel in the clay, and to yield an unfailing supply of good water."

Many of the wells in this parish, such as those at Green Farm (deeper than the Parish Well), Harrow Farm (more than 20 ft. deep), and Red House, are covered in and do not appear to yield such a good supply as the Parish Well.

English Bicknor—Maps : 233 ; [43 S.W.] ; (30 N.E., S.E., 31 N.W., S.W.)

The village is on the Carboniferous Limestone. Spring water has been piped to a public tap at the Almshouses and is laid on to two or three houses ; but otherwise it is dependent on shallow wells, many of which go dry in the summer, and rain water storage.

Lower Lydbrook is supplied by a spring (yielding about 300 gallons per 24 hours), between the Tin Plate Works and Hare's Grove, which is piped to a standpipe by the roadside opposite the Works.

At Hoarthorns are ' swallow-holes' (see p. 29).

Eyford—Maps : 217 ; [44] ; (21 S.E., 28 N.E.)

Between the source of the Eye and Eyford Park are the " Roaring Wells " of Eyford.[1] These springs, J. C. Cheetham, of Eyford Park, informs me, are very much smaller than they were some 30 to 40 years ago (from 1922) " when they really did roar." The water rushes out from the Cotteswold Sands on the west side of ' The Eye.' In May, 1922, there were three powerful springs and many other trickles all discharging into the brook which flooded the valley bottom below them, but Mr. Cheetham has stated that the springs often dry up entirely in the summer. (Analysis, p. 261.)

Eyford Park, Rockcliffe, Eyford Hill Farm, etc., are supplied from ' Milton's Well,' water from which is pumped to a reservoir. The spring issues from the base of the Cotteswold Sands. The well is on the east side of and close to ' The Eye ' just inside the Park.

Fairford—Maps : 235, 252 ; [34] ; (52 N.E., S.E., 53 N.W., S.W.)

Part of the parish of Fairford is supplied by an undertaking belonging to R. Barker of Fairford Park. The source of supply is a spring issuing from the Cornbrash, from which it is thrown out by the Forest Marble, under Fairford Old Mill. The water is piped to the following reservoirs and tanks:—Milton End, (*a*) 33,000 gallons, (*b*) 20,000 gallons ; Manor Farm, 1,400 gallons ; Fairford Park, 4,000 gallons ; Farhill Farm, 1,000 gallons ; and Leafield Farm, 1,000 gallons. The daily average quantity of water supplied is about 34,000 gallons. Houses not so supplied are dependent on wells. In the centre of Fairford these are 9 to 10 ft. deep and the water-level rises and falls according to the flow of the River Coln.

On the side of Waitenhill, where gravel rests on Oxford Clay, is a spring, the water of which is conveyed into a 2,000 gallon tank from which it gravitates to Burdocks and two lodges. Another spring near the above supplies Waitenhill Farm buildings and did not fail in 1921.

A useful spring issues from the Cornbrash near Barrow Elm Farm and there are numerous wells in the Cornbrash dotted about the fields.

[1] See ' [Excursion to] Eyford Park . . . ' *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), pp. 74, 75, pl. i.

Falfield—Maps: 251; [35]; (55 S.E., 56 S.W., 63 N.E.)

This parish is dependent on wells.

Farmington—Maps: 235; [44]; (36 N.E., S.E.)

A picturesque well (50 to 60 ft. deep through Great Oolite, which runs low at times but has not been known to fail) on the Green, Farmington, supplies adjacent houses; Bunkershill Spring, the cottages around; Hill House from The Wellings (p. 127), per a small reservoir ¼ mile west-north-west of the house; a few people fetch water from a spring ⅓ mile north by west of the Church; while Farmington Lodge and part of the village are supplied from a spring near the north-western extremity of Starveall Coppice (½ mile north by east of the Church), the water from which is pumped to a tank in the Lodge. In Oct., 1921, E. G. Hampshire informs me, it was pumping about 2,400 gallons per 24 hours. The springs are thrown out by the Fullers' Earth.

Park Barn is supplied by pipe from the Haycroft Spring in Sherborne parish; Grove Farm and cottages, sheds under Furzehill Wood and Camp Farm, from a spring in a field north of Starveall Coppice. Grove Barn gets its water from a spring near by.

E. G. Hampshire informs me that there are some good springs by the New Plantation running to waste. Two springs south of Clearcupboard are piped to a trough by the track-side a little under ¼ mile to the east.

Filton—Maps: 264; [35]; (68 S.W., 72 N.W.)

Filton is supplied by the West Gloucestershire Water Company, and there are very few wells in use.

Flaxley—Maps: 234; [43 S.E.]; (31 N.E., 32 N.W., S.W.)

The 91 houses in the parish are dependent on wells and springs. By the side of the road between Flaxley and Gunn's Mills, in the bend at the foot of the eastern slope of Welshbury (near the B.M. 194·9), is a trough. Water from the spring, issuing from the Old Red, which feeds this trough, supplies Flaxley Abbey and the Vicarage.

Forthampton—Maps: 216; [43 N.E. 44]; (11 S.W., S.E., 12 S.W.)

The village is on elevated ground composed of Keuper Marl. It is supplied by deep wells, usually dry-steined in the upper portion. (1) Almshouses: Draw well, 90 ft. to water with 2 ft. 6 in. of water. (2) Brewer's Cottages: Draw well, 80 ft. to water with 20 ft. of water. (3) Vine Farm: Pump, 76 ft. to water. (4) Pollock's Cottage: Draw well, 60 ft. to water. (5) Corner House Farm: Pump, 70 ft. to water with 5 ft. of water.

At Forthampton Court wells tap water at about 30 ft. The wells at (3), (4) and (5) are 'Whistling Wells.'

Boring at Southfield House.—Made for V. W. Yorke in 1927 by, and communicated by, Messrs. Duke & Ockenden.

[Keuper] Red marl	75 ft.

Lined with 6-in. tubes to 62 ft.

Yield.—Tested to 700 gallons per hour with suction at 60 ft. Rest-level 35 ft.

Frampton Cotterell—Maps: 250, 251, 265; [35]; (68 N.E., S.E.)

Frampton Cotterell is on the Coal Measures and is supplied by the West Gloucestershire Water Company. Houses in the parish not so served depend on wells and springs.

In 1882 E. B. Wethered wrote:—"Some years ago it was proposed to supply a portion of Bristol with water from the Frampton Cotterell iron

mines, which are in the Pennant, and the analysis made of the water showed it to be of good quality."[1] Subsequently an iron mine here was acquired by the West Gloucestershire Water Company (see p. 194).

Boring at Frampton Cotterell.—West Gloucestershire Water Co. Made and communicated by Messrs. C. Isler & Co., Ltd., 1925.

		Thickness Ft.	Depth Ft.
[Coal Measures]	Cattybrook Clay	78	78
	Red pennant	20	98
	Shale and red pennant	11	109
	Shale and blue pennant	34	143
	Blue pennant	111½	254½
	Black shale	5⅚	260⅓
	Blue pennant	108⅓	368⅔

Lined 76 ft. 8 ins. of 10 in. tubes top 1 ft. below surface.
Yield.—3,050 gallons per hour.

Frampton-on-Severn—Maps: 234; [43 S.E. 35]; (40 N.E., S.E., 48 N.E.)

This parish is on Lower Lias on the surface of which are locally extensive deposits of gravel.

J. D. Hodgkinson informs me that the well at Frampton Court is 10 ft. deep, through gravel into Lower Lias clay, and in May, 1922, there were five feet of water in it. The supply persisted during the drought of 1921.

Park Farm is one of the localities where experiments, described by Prof. [Sir] W. F. Barrett, with the divining rod, were carried out.[2]

Fretherne-with-Saul—Maps: 234; [43 S.E.]; (40 N.W., N.E., S.E.)

The village (on Lower Lias) and the parish as a whole are supplied by wells from 14 to 30 ft. deep. A. J. Mugliston informs me that the supply of water is adequate and the quality good.

Major Lionell Darell informs me that his well at Saul Lodge is 14 ft. deep, through gravel into Lower Lias clay with limestone bands, and that in May, 1922, there were 11 ft. of water in it. The water is hard. The drought of 1921 did not affect the supply.

Lower Familode is on Severn-side Alluvium resting on Lower Lias, the surface of which rises from beneath the Alluvium in the rear of the hamlet. Butler's Well (15 ft. deep, through a trace of Alluvium into Lower Lias) is made much use of as the water in most of the other wells is polluted. Exceptionally high tides in the Spring and fall of the year get up to this well. The Darell Arms has two wells: one (20 ft. deep) near the inn; the other in the field at the back of the inn. This latter well is in Lower Lias, was deepened to about 24 ft. and widened to 7 ft. in 1928, and when the work was completed 'the well was full.'

Frocester—Maps: 234; [35]; (48 N.E., 49 N.W., S.W.)

A number of springs issue from the gravel that rests on Lower Lias; some, as at Frocester Court and Downham Farm, are made use of. A few houses (*e.g.*, Elmtree Farm and Osborne House) have Stroud Water Co.'s water. The wells in the parish are from 6 to 25 ft. deep. In parts of the parish there is an insufficiency of water.

Hill Farm, by the side of the main road going to Frocester Hill and about half way up, is supplied from Tinker's Well, which is situate about 200 yds. S.W of the farm. The spring supplying this well has not been known to fail.

[1] *Rep. Brit. Assoc.* for 1882 (Southampton), p. 234.

[2] See *Proc. Soc. Psychical Res.*, vol. xv, 1900, p. 326; *ibid.*, vol. xiii, 1897, p. 71.

Gotherington—Maps: 216, 217; [44]; (19 N.E., 20 N.W.)

The village is mainly supplied by an undertaking provided by J. G. Villar. The source of supply is a spring thrown out by the Upper Lias clay high up on Nottingham Hill. To ensure supply the water is tapped by a well and pumped over the slight rise of the edge, whence it gravitates to a reservoir (capacity 6,500 gallons) at the Manor Farm, Gotherington, from which it is piped to the houses. Under normal conditions the supply is adequate, but it had to be conserved in the drought of 1921.

The Village Pump draws from a well that catches water which drains out of a gravel-bed.

There are a number of wells in the lower portion of the village in the sand-bed, in which there is an abundance of water. Water issues from this sand-bed in the field on the east side of the main road, three quarters of a mile north of the Farmer's Arms, and constitutes the source of the stream that flows a little to the south of Bozard's Farm. This water continued to issue throughout 1921, and when the village supplies were enfeebled its waters were taken from a dip on the west side of the road.

Great Badminton—Maps: 251, 265; [35]; (70 N.W., S.W.)

Village and parish are supplied by the West Gloucestershire Water Company. John Poore, Agent of the Badminton Estate, informed me (April 10th, 1922), that before the introduction of the Company's water "the supply at Badminton was from shallow wells."

Badminton Station (G.W.R.) is supplied with water by the West Gloucestershire Water Company.

Great Barrington—Maps: 235; [44]; (37, 45 N.W., S.W.)

As the Inferior Oolite is thin in this parish water could be readily reached in the village by comparatively shallow wells, but it is unlikely that its quantity would be great. Wells, however, are not now necessary, because M. E. G. Wingfield has provided a piped supply for the village from a spring at Taynton in Oxfordshire. There is a reservoir (10,000 gallons) in the Park.

Great Rissington—Maps: 235; [44]; (29 S.W., 37 N.W., N.E.)

There are a number of small springs in the village of which use is not made. The public supply is derived from two springs:—(1) $\frac{3}{8}$ mile N.E. by E. of the church, and (2) $\frac{1}{3}$ mile E. by N. of the church. There are tanks (330 gallons) and standpipes at the springs. The daily average quantity of water available is 2,000 gallons. The overflow from (2) is piped to a standpipe (3) 300 yds. E. of the church. As this spring ran low in 1921 there was no overflow for the stand-pipe; but spring (1) ran well all through the drought.

The Rectory, Northmoor and Manor Farms have piped supplies to tanks in the roofs from a spring (4) in a field on the east side of the road east of Horsehill Copse and $\frac{1}{2}$ mile S.S.E. of the church. This spring did not decrease in volume during the drought of 1921. The overflow from the tank at the Rectory feeds a stand-pipe (5) some 70 yds. east of the school.

Park Farm has a piped supply from the vicinity of the copse $\frac{5}{6}$ mile N.N.E. of the church. There is only one well in use in the hill-portion of the parish—at the Lodge $\frac{3}{4}$ mile N.E. by E. of the church (6). It is 33 ft. deep, through Inferior Oolite, and usually has about 3 ft. of good water in it, but it ran dry in 1921. Water at Park Barn (7) is connected with the Park Farm supply. At The Folly (8), $\frac{3}{4}$ mile E. by N. of the church, is a spring, tank and pump. At Hill Barn (9) is a pump, but the spring has been dry for some years. There are a number of springs in the vicinity of Horsehill Copse, which are not used for the purpose of any supply.[1]

[1] I am indebted to E. Speller for much of the above information.

All the springs in the hill portion of the parish are thrown out from the base of the Inferior Oolite by the Upper Lias clay.

Great Washbourne—Maps: 217; [44]; (13 N.W., S.W.)

This parish is mainly on Lower Lias clay on the surface of which, however, running under the village, is a sand-bed.

The village obtains its supply from standposts, wells and springs. The standposts are supplied with spring water that issues from at or near the junction of the Lower Lias clays and the Sandy Beds of the Middle Lias in the side of the Washbourne Hill towards Didcot Farm. The water is turbid and not used for drinking: some three wells and a spring at the back of Great Washbourne Cottages are drawn for that purpose. There is an abundance of good water in the superficial sand-bed and the water 'boils up' in the 'Cottages' Spring,' in a pond to the south, and issues into the stream in the orchard to the west of the 'Cottages' Spring.' When the stream was dry in 1921 the 'Cottages' Spring' was running strongly, as well as that discharging into the stream-course in the orchard. In the drought of 1921 a hole was dug in the bottom of a small sand-pit on the northern outskirts of the village, a tub was inserted, and a continuous supply of water was obtained. It is obvious that a supply adequate for the needs of the village and satisfactory as regards quality is contained in the sand-bed.

Great Witcombe—Maps: 234; [44]; (34 N.W., S.W.)

Part of the parish is supplied by an undertaking that was provided by W. F. Hicks-Beach. Spring water, thrown out by the Upper Lias clay, is piped to the Round House where there is a tank from which it is pumped by those living around. Those not so supplied obtain their water from wells and springs. Green Farm draws its water from the head of a stream that runs into the Witcombe reservoirs.

The Witcombe reservoirs of the Gloucester Corporation are in this parish (p. 220). In 1881, when the Corporation was seeking for an additional supply of water, J. F. Bateman recommended driving a tunnel a mile and a quarter into the hill, commencing in the Upper Lias clay, and rising into the basement beds of the Inferior Oolite, so to tap the water on the dip-slope. He was of opinion that it was probable that 200,000 to 300,000 gallons of water a day would be obtained. In order to test this view four boreholes were made along the line indicated in Fig. 5.

No. of Borehole	Ht. above O.D.	Total depth of Borehole	Upper Lias proved below surface at	Rest-level of water proved below surface at	Remarks
	Ft.	Ft.	Ft.	Ft.	
No. 3	721·01				Proved slipped Oolite on Cotteswold Sands
No. 4	935·98	300	190·98	190·98	
No. 2	923·66	274	186	176	
No. 1	893·37	393½	195	160	

[1] Lucy, W. C., *Proc. Cotteswold Nat. F. C.*, vol. viii, 1884, pp. 165-6; C. E. de Rance, *Rep. Brit. Assoc.*, Southport, 1883, p. 150; R. Read, *Trans. Inst. Water Eng.*, vol. xvii, 1912, p. 163 and Fig. 3.

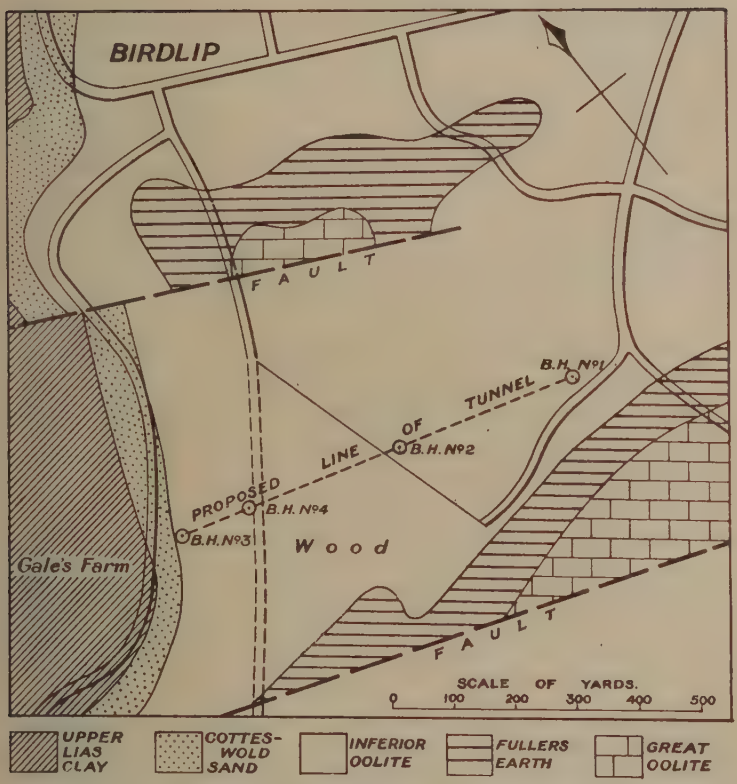

FIG. 5.—*Map showing trial holes made in connexion with a search for an additional supply for Gloucester.*

The rock, pierced by the borings between the surface and the clayey Cotteswold Sands, was Inferior Oolite. In No. 4 it was 195 ft. thick, nearly its total thickness. Between Nos. 1 and 2 the dip was 1 in 26. No. 4 went 108 ft. 6 in. into the Upper Lias deposits.[1]

The borings proved that the depth of water in the rocks above the Upper Lias clay increased from 10 ft. near the escarpment to 35 ft. 1,600 ft. away to the east-by-south in the upland.

Guiting Power—Maps: 217; [44]; (21 S.W., 28 N.W.)

The village is situate on a steep hillside partly on Inferior Oolite and partly on Cotteswold Sands. It is supplied by a strong spring at the bottom of the village near the old mill. The spring[2] issues from the Cotteswold Sands, and at the end of October, 1911, the yield was 54,000 gallons per 24 hours. It is situate rather close to the village, but its outlet is well protected. The water is pumped by a couple of rams to a reservoir near Quarry Cottages whence it gravitates to standposts in the village.

[1] See Richardson, L., *Proc. Geol. Assoc.*, vol. xx, pt. 7, 1908, p. 521.

[2] This is the spring noticed by Dr. S. W. Wheaton in his 'Report . . . on the Sanitary Circumstances . . . of the Winchcomb Rural District. . . .' 1907, p. 3, as "a very powerful spring at the bottom of the village."

Previous to 1913 the village obtained its water from the above-mentioned spring and draw-wells. Some of these draw-wells were very deep (90 ft.), not steined, and the water from them was sometimes foul in dry weather because, owing to their great depth and want of steining, it was almost impossible to clean them out.

Castlett Farm and buildings are supplied from a spring issuing from the base of the Cotteswold Sands. At Guiting Grange is a borehole, 200 ft. deep, the water from which supplies The Grange, gardens and House Farm.

Hailes—Maps: 217; [44]; (13 S.E., 20 N.E.)

The few houses in the neighbourhood of the Abbey ruins constituting the village have water laid on from the Lyne's Barn Supply (p. 134). The overflow from this supply discharges into Hailes fish-pond.

Ham-and-Stone—Maps: 250, 251; [35]; (47 S.E., 55 N.W., N.E., S.E., 56 N.W., S.W.)

The parish is dependent on wells: the public well on Ham Green is about 25 ft. deep, that at Clapton about 20 ft. deep.

Hamfield Farm, on an inlier of Keuper Marl, is amply supplied from a well 12 ft. deep in the marl.

Hamfallow—Maps: 234, 251; [35]; (47 N.E., S.E., 48 N.W., S.W.)

Some 10 houses in the parish are served by the Berkeley Estate Supply from Wanswell, but otherwise the parish is dependent on wells, the majority of which are shallow, but are said to always contain plenty of water. Thus a well in the Old Red Sandstone at Pit Brook, between Haynes' Farm and Wanswell Green, is 7 ft. deep, and on July 15th, 1922, had 4 ft. of water in it. Locally it is said that there is plenty of water anywhere in the neighbourhood at 3 ft. down.

The well-known Wanswell spring issues from about the junction of the Ludlow and Old Red Sandstone about a quarter of a mile to the north of Wanswell Court Farm. The spring water is stored in a reservoir (50,000 gallons) near the spring head, whence it is piped to Berkeley for the use of the Castle and a number of houses in Berkeley (p. 55). The overflow feeds the moat around Wanswell Court Farm.

Boring at the Dairies near Berkeley Station.—Made for F. W. Gilbert in 1916 and communicated by Messrs. Duke and Ockenden.

	Thickness Ft.
Dug well:—	
Old Red Sandstone	43
Boring:—	
Old Red Sandstone ? and Silurian ...	260

Lined with 8-inch tubes down to 76 ft. from the surface. Rest-level of water, 20 ft. down.

This borehole was deepened by Messrs. Mansfield to 450 ft.

H. E. Hornby, a Director of Messrs. F. W. Gilbert, Ltd., informs me (31st July, 1922):—"As far as I can say there is an average supply of something like 700 gallons per hour at 450 ft. depth. Our Factory Manager was of opinion that what water was found was encountered at about 250 ft."

Hampnett—Maps: 235; [44]; (36 S.W., N.W.)

Hampnett Village, partly on the basement beds of the Great Oolite and partly on the Fullers' Earth, is adequately supplied with good water from wells and from a spring in the village.

The spring marked ' W ' on the six-inch map, near the B.M.684·1, supplies a few cottages in the village, the Manor House, Furzenhill Barn and Oldhill Barn ($\frac{5}{6}$ mile south by east).

The tank by the wood called ' The Mine ' is a field-trough fed by a small spring in the wood. In Prison Copse is a spring that used to supply Messrs. Taylor & Co.'s Cotswold Brewery, Northleach (now closed) but now running to waste, which in Sept., 1914, E. Hampshire, Sanitary Inspector, Northleach Rural District Council, informs me, yielded 6,500 gallons per day.[1]

Hanham Abbotts—Maps : 264, 265 ; [35] ; (76 N.W., N.E.)

At Hanham Abbotts, on the Coal Measures, according to the L.G.B. Return, 1915 (p. 429), 100 out of 161 houses are supplied by the West Gloucestershire Water Company and those not so supplied are dependent on wells.

Hardwicke—Maps : 234 ; [43 S.E.] ; (32 S.E., 33 S.W.)

This parish is on Lower Lias on the surface of which are locally deposits of gravel. It is supplied by wells 20 to 40 ft. deep and rainwater. The water in many of the wells is saline.

G. E. Lloyd-Baker informs me that he has a well in clay with some admixture of gravel, of good water which is pumped to the top of Hardwicke Court house. Some 30 years ago he supplemented the supply from a spring some 400 yds. away which issues from a bed of gravel. This water is not very ' salty,' and came in slowly during the drought of 1921, but never completely stopped. At many places, however, he stated, for example at his Lower Lodge (which is in Haresfield parish), the well-water is very hard and slightly brackish. Mr. Lloyd-Baker also informs me that along the Bristol Road near the Four Mile Elm any deep well yields brackish water. At The Cottage the well water is distinctly aperient and the same remark applies to the well water at the School Farm near the Stank Bridge. A supply of softer water is laid on from the hill beyond.

Harescombe—Maps : 234 ; [43 S.E., 44] ; (33 S.E., 41 N.E.)

Numerous springs issue from at or near the base of the Cotteswold Sands. Mr. Mugliston informs me that a spring at the back of Brook Farm is fairly strong and has never been known to fail.

The parish is supplied by wells, from 20 to 30 ft. deep, and from springs. Dr. M. Ashley, M.O.H., in his report for 1914, stated that twelve cottages were dependent on a stream 200 to 300 yds. distant which was liable to pollution.[2]

Haresfield—Maps : 234 ; [43 S.E.] ; (40 N.E., 41 N.W., N.E.)

The village is on Lower Lias clay. The parish is mainly dependent on wells and springs, but R. I. Tidswell of Haresfield Court has a reservoir under the Beacon, fed by the " Beacon Spring " and other small springs issuing from at or near the base of the Cotteswold Sands, to supply his estate. The yield was only slightly affected by the drought of 1921.

The wells in the Lias of the vale are from 16 to 25 ft. deep and provide an adequate supply.

Harnhill—Maps : 235, 252 ; [34] ; (51 S.E., 52 S.W.)

The village of Harnhill is supplied with water raised by a windpump from a spring at the south-western end of Westhams Copse to a tank (12,000 gallons),

[1] An analysis by Messrs. J. M. Collett & Co., Ltd., is given in *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 1 for 1924, 1925, pp. 49, 50.

[2] See Ann. Rep. M.O.H. for 1914, 1915, p. 154. Glos. C.C.

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whence it gravitates to Harnhill House, Rectory, and to two standposts (taps) and is also laid on to the fields. A "Village Spring" yields a constant supply: E. J. Mathews informs me that "it rises 18 in. into a brick tank and supplies five cottages."

E. J. Mathews also informs me that there is a 3-inch boring at Waterton 90 ft. deep, in which the water stands at 45 ft. ex surface. The supply is unfailing and the water is raised to a 500-gallon tank from which it gravitates to Waterton House and Farm. A spring a little lower down feeds a trough by the side of the London road.

Boring 200 *yds. S.W. of Harnhill Church.*—Made and particulars communicated by Messrs. Thomas Tilley and Sons. Supplies Manor House near Church.

		Thickness Ft.	Depth Ft.
	Top soil	1½	1½
[? Cornbrash (part) and Forest Marble (part)]	1. Grey rock	31½	33
[Forest Marble]	2. Blue marl	20	53
	3. Blue rock	5	58
	4. Forest Marble	19	77
	5. White rock	2	79
	6. Hard blue rock ...	12	91

Water encountered at 32 ft. which rose to 18 ft. ex surface.

Water encountered at 65 ft. which rose to 34½ ft. ex surface and lowered the top 'spring' to that level.

Lined with 4-inch tubes to 55 ft.: open borehole below.

Hartpury—Maps: 216; [43 N.E., S.E.]; (17 S.E., 18 S.W., 24 N.E., 25 N.W.)

The greater part of the parish is on Keuper Marl.

Village and parish are dependent on wells, the water in many of which is inadequate in quantity and of poor quality.

Hasfield—Maps: 216; [43 N.E.]; (18 N.W., S.W., N.E., S.E.)

Village (on Keuper Marl) and parish are dependent on wells. The houses in the village north of the Church near the 100-foot contour-line have deep dry-steined wells: that at Rose Cottage, 63 ft. deep with about 6 ft. of water, is a typical well. The houses in the lower part of the village have shallower wells with hand-pumps. It would appear that the rest-level of the water in the Marl here is about 20 ft. above O.D.

Hasfield Court derives its supply from a spring issuing from at or near the base of the Lower Lias near Hill Farm. The water is piped to the Court and supplies a standpost in the road opposite the School. Hill and Woodside Farms have shallow wells in the Lower Lias.

Hatherop—Maps: 235; [34]; (44 N.E., S.E., 52 N.E., 53 N.W., S.W.)

Hatherop is supplied by the undertaking provided by the trustees of the late G. S. Bazley of Hatherop Castle.

Boring at Hatherop Castle.—Made by the Aqueous Works and Diamond Rock-Boring Company in Sept. to Oct., 1887.

Description published by H. B. Woodward.[1]

[1] 'The Jurassic Rocks of Britain,' vol. iv (*Mem. Geol. Surv.*), 1894, p. 510.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Valley Gravel	Light loam	5	0	5	0
	Gravel	6	0	11	0
Forest Marble	Clay	3	0	14	0
Great Oolite	Limestone	39	3	53	3
	Yellow sandy clay	7	6	60	9
	Blue clay	1	0	61	9
	Grey limestone	1	5	63	2
	Blue clay	4	10	68	0
	Blue limestone	1	7	69	7
Fullers' Earth	Blue clay	44	5	114	0

The water is raised to three standposts in the village and to tanks at :—(1) Hatherop Castle (over Estate Office), 10,650 gallons ; (2) Rectory, 500 gallons ; (3) Church Mead, 500 gallons ; (4) Glebe Farm (granary), 10,000 gallons ; (5) Glebe House and Farm, 5,000 gallons ; (6) Home Farm, 5,000 gallons ; (7) Barrow Elm and Homeleaze, 15,000 gallons ; (8) Dean Farm (in the Leach Valley), 20,000 gallons. This artesian well also supplies other premises outside the Cirencester Rural District.

South Farm (or Manor Farm) is supplied from a spring issuing from the Cornbrash, between the farm and Fairford Station (G.W.R.). The water is forced (by ram) to tanks and laid on to the farm and buildings and two cottages.

Hawkesbury—Maps : 251 ; [35] ; (64 N.E., S.E., 65 N.W., S.W., 69 N.E., 70 N.W.)

In this parish are Hawkesbury, Hawkesbury Upton, Hillsley, and Tresham. Hawkesbury is dependent on wells.

The greater part of Hawkesbury Upton is on Great Oolite and is dependent entirely on wells, the most important being the Parish Well in the centre of the village. The pool, near Pool Farm, is on the Fullers' Earth and a useful spring is thrown out by this formation by the roadside between Pool Farm and Hawkesbury Church. Henry Martin, formerly of the West Gloucestershire Water Company, tells me that this pool was dry on 6th July, 1921, and water had to be carted from Kilcott for cattle and general use ; while drinking water had to be fetched from the spring.

Hillsley is on the Middle Lias. It is supplied from a spring issuing from the base of the Cotteswold Sands 147 yds. E. of Hillsley Church. The water is forced (by rams) to a tank on the hill-top to the south from which it gravitates. The water is laid on to some houses and to standposts.

Tresham is on the Great Oolite just above the Fullers' Earth. It is supplied from springs thrown out by the Fullers' Earth at the head of the valley (on the 600-foot contour-line) in the hamlet. The water runs direct into tanks at the spring head from which it is taken by dipping.

Dunkirk and Petty France, on the Great Oolite, are supplied by the West Gloucestershire Water Company.

Hawling—Maps : 217 ; [44] ; (27 N.E., S.E., 28 N.W., S.W.)

The village is supplied by a private undertaking. The water is obtained from a spring, thrown out by the Fullers' Earth, situate about half a mile to the east of the village. The water is raised by a ram to a reservoir at South Down Barn (14,500 gallons capacity), from which it is laid on to the majority of the houses, and to standposts.

Numerous springs are thrown out by the Fullers' earth in the parish, but many cease to flow in times of drought.

Hazleton—Maps: 235; [44]; (28 S.W., 36 N.W.)

A number of springs are thrown out by the Fullers' Earth. The majority are feeble and their waters, except in very wet weather, run over the outcrop of the Fullers' Earth and sink into the permeable Inferior Oolite. The spring ½ mile east of the Puesdown Inn, however, is fairly strong, and that ⅓ mile south-east by east of the Church was drawn on by the villagers before the reservoir (see below) was built.

The village is supplied by wells and by a private undertaking. The wells are from 20 to 30 ft. deep and the supply is constant, but they are not now largely drawn on. Priory Farm and several cottages in the village are supplied from a spring about ⅓ mile south by east of the Church, where a small oil engine pumps the water to a reservoir half a mile south-west of the Church from which it gravitates.

Hempsted—Maps: 234; [43 S.E.]; (25 S.W., 33 N.W.)

Out of 115 houses in the parish, 13 are supplied with Gloucester Corporation water. Those not so supplied are dependent on shallow wells, some of which contain saline water (p. 262).

Lady's Well is situate on a steep bank to the north of the Church.[1] At the present time the spring water, which issues from sand and gravel resting on Lower Lias, discharges through a pipe into a trough outside the building.

Henbury—Maps: 250, 264; [35]; (67 N.W., N.E., S.W., S.E., 71 N.W., N.E.)

Henbury village is supplied by the Bristol Waterworks Company, whose mains go out as far as Hollywood Towers, and wells[2] (analysis, p. 262).

The public well at Hallen is about 20 ft. deep in Keuper Marl and gave a good supply throughout 1921. The wells in the Alluvium yield peaty water.

Charlton is served by the West Gloucestershire Water Company.

Hewelsfield—Maps: 233, 250; [35]; (46 N.E., S.E.)

The village of Hewelsfield is dependent on a Village Pump (over well in the Lower Limestone Shales). The water is said to be not very good, as "it sometimes seems a little rusty," and went low during the drought of 1921. Water had then to be fetched from taps on the Hewelsfield Court estate, which are supplied from a catch well fed by a spring issuing from the Old Red Sandstone up the old lane north-west of the Court.

The Carpenters Arms inn has a pump (? over a rain-water tank) and the cottages below have rain-water tanks; but when the supply gives out water has to be fetched from the Village Pump.

Hidcote Bartrim—Maps: 200; [44]; (8 N.W.)

Hidcote Bartrim itself comprises some 11 houses of which 10 have a piped supply provided by Mrs. G. C. Winthrop. The water comes from a spring thrown out by the Upper Lias clay at Hill Barn on the side of Hidcote Hill—a portion of the western part of Ebrington Hill. The water gravitates to a reservoir (8,000 gallons) at Baldwyn Farm. The average daily quantity of water obtained is 8,000 gallons and a further 16,000 gallons is said to be available. The supply is constant and the water good but hard.

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[1] *Trans. Bristol and Glos. Arch. Soc.*, vol. xiii, p. 53; *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), pp. 84, 85, pl. ii, fig. 1.

[2] There are wells in the parish of great depth—one in the Carboniferous Limestone is 150 ft. deep.

Highleadon—Maps: 216; [43 S.E.]; (17 S.E., 24 N.E.)

One farm and two cottages are served from the Gloucester Corporation's main, but otherwise the parish is dependent on wells.

Highnam-Over-and-Linton—Maps: 216, 234; [43 S.E.]; (24 S.E., 25 S.W.)

Of the 67 houses in the parish 7 are supplied with Gloucester Corporation water: others are dependent on wells.

Hill—Maps: 250, 251; [35]; (55 N.W., S.W., N.E., S.E.)

The parish is dependent on wells. The quality of the water of the wells in the Alluvium is poor.

Hinton—Maps: 234, 251; [35]; (40 S.W., 47 N.E., S.E., 48 N.W.)

The parish is dependent on wells, up to about 40 ft. in depth. Thus two wells in Station Road, Sharpness, are 30 and 40 ft. deep respectively in the Old Red Sandstone and the latter has 20 ft. of water in it.

Hinton-on-the-Green—Maps: 200, 217; [44]; (6 N.W., N.E., S.W., S.E.)

The water-supply is obtained from the Evesham and Pebworth Joint Water Committee.

In 1804 a shaft was sunk at Haselor, to the north-west of Hinton-on-the-Green, in quest of coal. It proved[1]:—

	Ft.	
Lias [and Rhaetic] beds about	75	(At 51 ft. a strong spring)
Red marl, about	282	
Gypsum	1	
Grey and red strata	47	
Black strata	15	
Red and white beds with gypsum ...	387¾	(At 582 ft. a thin vein of coal [?])
	807¾	

Horsley—Maps: 251; [34, 35]; (49 S.W., S.E., 57 N.W., N.E., S.E.)

The village of Horsley is supplied by the Stroud Water Company, which has a service tank at Nupend. Horsley Vicarage has a piped supply from a top-level spring thrown out by the Fullers' Earth. Top-level springs rising at Nupend feed dip wells in the main street: Dr. J. Middleton Martin once found the water in the top dip well quite pure, but in the bottom one totally unfit for drinking purposes.[2] These Nupend springs were once considered by the Stroud Water Company as a source of supply for the locality to save pumping, but they ran too feebly at times. The Be-Thankful Fountain in the Horsley road is supplied from top-level springs, which ran feebly in 1921, situate ⅛ mile S.E. by E. of All Saints Church, Shortwood. There is a good spring, called 'Coldwell,' by the side of the Horsley Brook near Willow Cottage. It issues from the Cotteswold Sands. There is a dip and a tank from which a pipe is laid to supply Willow Cottage. On the right hand side of the path south of Coldwell is a dip with a circular opening.

Bartonend is supplied by the Stroud Water Company; but Upper Bartonend from a top-level spring the water from which is pumped up by a ram. There are some useful springs down Bartonend Lane.

[1] 'Memoirs of H. E. Strickland' by Sir William Jardine, 1858, p. 83.
[2] Ann. Rep. of the M.O.H. for the Stroud R.D. for 1901 (1902), p. 3.

Boring at Chavenage.—Made in 1893-94 by T. Holloway of Chippenham. Particulars communicated by G. Lowsley-Williams of Chavenage House and published by L. Richardson.[1]

Record by T. Holloway; classification of strata by L. Richardson.

Surface-level.—527 ft. above O.D.

		Thickness Ft.	Depth Ft.
Forest Marble	Surface soil...	1	1
	Shelly oolitic limestone ...	11	12
	Grey marly clay	27	39
Great Oolite (63 ft.)	Shelly oolitic limestone ...	22	61
	Oolite	19	80
	Shelly oolitic limestone ...	22	102
"Passage Beds" (56 ft.)	Grey, gritty, oolitic rock ...	2	104
	Grey, calcareous gritty rock .	16	120
	Grey marly clay	18	138
	Grey, calcareous gritty rock	20	158
Fullers' Earth (88 ft.)	Grey marly clay	34	192
	Grey, calcareous gritty rock	2	194
	Grey marly clay	52	246
Inf. Oolite with Cephalopoda Bed at base (134 ft.)	Grey, calcareous gritty rock	11	257
	Grey shelly limestone ...	123	380
Upper Lias	"Strong clay, sample not seen	3	383

Lined with tubes to a depth of 258 ft. Water-level.—12th May 1914—226 ft. below surface; Jan., 1894.—235 ft. below surface.

(According to a note on a copy of T. Holloway's section the water—presumably shortly after the boring was completed—stood at 233 ft. ex surface, but dropped 100 ft. on pumping).

G. Lowsley Williams informs me that "the supply is ample, and even with a steam pump has proved sufficient, the tank holding about 12,000 gallons." An analysis of the water is given on p. 276.

Horton—Maps: 251; [35]; (64 S.E., 69 N.E., 70 N.W.)

Horton village is on the Middle Lias and is dependent on wells which are said to yield satisfactory supplies. Certain farms on the hills, such as Grickstone Farm, are supplied by the West Gloucestershire Water Company.

Hucclecote—Maps: 216, 234; [44]; (25 S.E., 26 S.W., 33 N.E., 34 N.W.)

Out of 280 houses, 207 are supplied with the Gloucester Corporation water; those not so supplied are dependent on wells about 15 ft. deep.

The well at Dingle Well Cottages is about 8ft. deep in Lower Lias, and for the past forty years has never been known to have in it less than 3 ft. of excellent, but hard, water.

Huntley—Maps: 216, 234; [43 S.E.]; (24 S.W.)

The Llandovery Beds contain a fair amount of water. In 1854 and 1891, when additional sources of supply were sought for Gloucester, it was suggested that a reservoir should be constructed in the valley just below Huntley Church, at Woodend, to impound the waters issuing from the depression between Huntley and Bright's Hills. W. Fox[2] investigated the various

[1] *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 3, 1914, pp. 243-246.

[2] Fox, W., "Report on the best means of increasing the Water Supply of the City of Gloucester," 1st June, 1891, p. 8.

schemes on behalf of the Gloucester Corporation, and turned down this Huntley Hill scheme, on account of the doubtful quality of the water.[1]

The parish is dependent on wells, rainwater storage and springs. In the vale, on the Keuper Marl, wells fitted with pumps are the rule ; on the high ground, draw-wells and dip wells (catching springs). Some of the houses in the lower portion of Little London, but in this parish, are poorly off for water : water has to be fetched from a small spring which ' boils up ' in a boggy patch from Llandovery rock near the north-eastern foot of Nottswood Hill in Blaisdon parish. The water is caught from a spout by the side of Ley Brook. A little lower down the hill at Henfield House (205 ft. above O.D.), a well sunk in the Llandovery Beds is 55 ft. deep and has normally 6 to 9 ft. of water in it.

Iccomb—Maps : 217 ; [44] ; (29 N.W., N.E., S.W.]

Water that has percolated the Oolites is thrown out by the Upper Lias as numerous springs and a number of these provide the main supply of the village. Capt. G. H. Simpson-Hayward, of Iccomb Place, has furnished me with the following information :—(*a*) The Gawens is supplied by pipe from a spring (which ceased to flow for the first time in September, 1921) $\frac{1}{6}$ mile W. by N. of Iccomb Place. (*b*) Iccomb Place has a piped supply from a spring $\frac{1}{5}$ mile E. of the house. (*c* and *g*) The waters from these two springs—one (*c*) an excellent spring, situate immediately to the S. of Hill Barn ($\frac{1}{4}$ mile W. by S. of Iccomb Place), and the other (*g*) immediately to the N.E., are pumped to Iccomb Tower for the supply of the farm. (*d*) A spring 250 yards N.N.W. of Iccomb Place supplies by pipe The Knolls and certain cottages. (*e*) Depth of well at Village Pump not known. (*i*) A spring 250 yards N.W. by W. of Iccomb Church supplies the village tap (*f*). (*j*) A spring in the field below the coppice S.E. of Mangersbury Grove is piped to supply the Rectory, a farm, etc. The springs in Gawcombe N.W. Wood, constituting the headwaters of Westcote Brook, are not used.

Iron Acton—Maps : 250, 251 ; [35] ; (68 N.E., 69 N.W.)

The parish is dependent on wells, the supply from which is ofttimes inadequate.

Kemble—Maps : 252 ; [34] ; (51 S.W., 58 N.E., 59 N.W.)

The water-table in the Great Oolite under this parish fluctuates considerably, causing the rest-levels of the water in the wells to rise and fall in most cases between well-separated limits. At the Great Western Railway Pumping Station at Kemble Junction, two million gallons of water are pumped up daily out of wells in the Great Oolite and flow by gravitation through a 9-in. main laid alongside the railway to Swindon Works. There are some deep wells in Kemble village, but now they are mostly dry. In wet weather, when the water-table rises above the bottoms of the valleys, such depressions as those at Smerrill and Jackaments Bottom are flooded.

Kemble village is supplied with water, in bulk, by the Great Western Railway Company. The water is conveyed through a 3-in. main and is laid on to Kemble House, Kemble and Gordon Lodges, Yew Tree House, The Limes, Vicarage, etc., to taps in the village, and Clayfurlong Farm. The average daily quantity of water supplied is 2,870 gallons. The total hardness of the water is 18·4° ; temporary hardness, 12·9°.

Clayfurlong Farm house is supplied from the village mains ; but the fields from Lyd Well,[2] from which the water is raised by a windpump to a 7,000-gallon concrete tank. Lyd Well is situate 800 yds. north of Clayfurlong

[1] *Ibid.*, p. 13.

[2] *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), p. 164, and pl. vii, figs. 1 and 2.

Farm and 500 yds. south-east of the disused Thames and Severn Canal Pumping Station. It is held by some to be a Roman well and mentioned in Doomsday Book. A better site for a well could not have been chosen ; it is the last at which water would fail in the valley. It is 14 ft. deep in the upper beds of the Great Oolite. There is a borehole (6 in. diameter) from the bottom. From the bottom of the well a culvert, 2 ft. by 2 ft., runs some 100 yds. in a south-westerly direction, and has two hand-bored holes in its bottom. The culvert drains water from the valley into the well. Gordon B. Young, of Clayfurlong Farm, informed me that water overflows from the well for about half the year, and although the water went low during the drought of 1921 it did not fail. There are indications that a culvert ran from this well for some 500 yards up the valley to the large well in the valley some 100 yards south-west by south of the old Thames and Severn Canal Pumping Station.

Thames Head Well is that at the Pumping Station of the disused Thames and Severn Canal. J. H. Taunton furnished E. B. Wethered with the following particulars concerning this well[1] :—

Sunk about 1793. Ground-level 364 ft. above O.D. Well 63 ft. deep (in Great Oolite) ; section oval, 15 ft. by 10 ft. No borehole below bottom of well. Original drift-way 30 yds., subsequently extended down the valley some 500 yds. (? connecting with Lyd Well) tailing into a cutting about 17 ft. in depth. Yield :—The quantity of water pumped from 1,500,000 to 3,500,000 gallons a day (analysis, p. 263). The water-level varies from 30 to 53 ft. below the surface, according to the season and pumping. When the engine pumps continuously it usually lowers the water-level gradually, in a dry season, 3 or 4 ins. a week. As the springs break in the neighbourhood the water rises rapidly. There does not appear to be any material change in the normal level of the water. Apart from the continuous pumping for the supply of the summit-level of the Thames and Severn Canal the water-level is determined by that in the gravel in the bed of the adjoining valley, and rises and falls with it. There has been no perceptible diminution during the last 30 years (from 1882), and the supply is not affected except by long continued rains in the Cotteswold District on the north-west. No large faults are known to exist close to the well.

John Bravender " . . . found there were 9 ft. of water in the well, and the engine was producing no effect on the level, although the country was dry and there was scarcely any water in any of the rivers or brooks. He considered that the water held up by the Fullers' Earth in the neighbourhood of Thames Head would not reach the surface in summer time. Prof. Allen Harker has stated that the Thames rose in Trewsbury Mead before the Canal Company put in their pumping machinery—now it rises half a mile or more lower down its course."[2]

Dr. T. Wright and D. J. Humphris " . . . were informed by Mr. Hayward, of the Inn at the Tetbury Road Station, that the effect of the pump at Thames Head Pumping Station is felt over a radius of two miles."[3]

Gordon B. Young informs me that from the Thames Head Well a culvert goes to the well near the cottages close at hand, and another to the large well (21 ft. deep., 11 ft. in diameter) in the field some 100 yards to the south-west by south. From this large well a culvert, cut in the rock (10 ft. high by 6 ft. wide), runs about 100 yards in a west-south-westerly direction. In addition there appears to have been a culvert connecting with Lyd Well—some 500 yds. down the valley. The main Thames Head Well was thus kept well supplied.

A well in the Great Oolite at Jarvis's Quarry (at about 380 ft. above O.D.) is 32 ft. deep and supplies three cottages. It was not possible to sink it any deeper because " the water came in on top of the sinkers."

[1] *Rep. Brit. Assoc.*, Southampton, 1882, pp. 227, 228.

[2] Woodward, H. B., ' Jurassic Rocks of Britain,' vol, iv (*Mem. Geol. Surv.*), p. 509.

[3] ' Report on the Sources of an Additional Supply of Water to the Town of Cheltenham,' Cheltenham, 1863, p. 18.

A well in the valley-bottom near Smerrill farm-yard is 27 ft. deep. It was dry in August, 1921; but in winter water rises up and flows over the lip of the well, and the valley-bottom floods.

The hollow between the farm and the Crudwell Road in Jackaments Bottom floods in winter, when the water-table in the Great Oolite rocks rises. The ground slopes inwards from all directions, so the water eventually disappears by soaking back into the ground.[1]

A well in the garden south of Jackaments Bottom Farm is 16 ft. deep, but the supply is uncertain because the well is not sunk below the lower limit of the water-table. Water for the farm and buildings has been laid on from Mountpleasant (Rodmarton) Supply (p. 139).

The smaller houses in Ewen are dependent on wells: Mr. Fawcett's house has water from one of the Ewen Springs, which issue from the Cornbrash, pumped to it.

Boring at Ewen Field (or Park Leaze) Barn.—Particulars communicated by E. J. Mathews.

Surface-level 392·4 ft. above O.D. Boring (6-in. diameter):—

Forest Marble and Great Oolite	120 ft.

The yield is good and has not failed. The water is raised to a 4,000-gallon tank in the barn from which it gravitates to two cottages, farm buildings and Ewen Farm House.

Boring at Kemble.—Outside the Pumping Station, Kemble Station. Trial boring made in 1911. Record by L. Richardson.[2]

Borehole, 353 ft. deep. Line-level 356 ft. above O.D. Well (through embankment) 27 ft. 6 in. deep. Top of borehole 328 ft. 6 in. above O.D.

		Thickness Ft.	Depth Ft.
Great Oolite	1. Pale yellow oolitic limestone with a few shell-fragments and small gastropods	60	60
'Passage-Beds'[3]	2. Limestone, hard, blue-black (with sporadically-distributed yellow oolite-granules) separated by layers of somewhat sandy rock	10	70
	3. Sandstone, grey, fine-grained, micaceous, calcareous, compact in some places, fissile in others	12	82
	4. Marls, grey, sandy in places, with very shelly layers; *Rhynchonella, Chlamys vagans* (Sow.), *Pseudomonotis, Volsella imbricata* (Sow.), etc.	26	108
Fullers' Earth[4]	5. Marls, similar in many respects to those composing bed 4. The upper part is sandy and indurated, the lower more marly, and when dry from exposure, breaks up with a conchoidal fracture into irregular pieces. Some very shelly layers occur, being crowded with crinoid-ossicles and specimens of *Ostrea acuminata* J. Sow. ...	73	181

[1] *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 1 for 1924 (1925), pp. 14, 15, and pl. i, fig. 1; *Proc. Geol. Assoc.*, vol. xxxvi, 1925, p. 86.

[2] *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2, 1913, pp. 185-189.

[3, 4] *See* footnote next page.

		Thickness Ft.	Depth Ft.
Inferior Oolite	6. Rubbly Beds. Ragstone, rubbly, shelly, bluish; *Terebratula globata* auctt. (common), *Rhynchonella*, *Entolium*, etc. ...	4½	185½
	7. White Oolite. Limestone, bluish, oolitic	15	200½
	8. Clypeus Grit. Ragstone, rubbly, shelly; usual fossils	7	207½
	Non-sequence. Upper Coral-Bed and Dundry Freestone wanting		
	9. Upper Trigonia Grit. Ragstone; usual fossils	6	213½
	Non-sequence. All the beds of the hemerae *niortensis* to *bradfordensis* (incl.) wanting		
	10. Lower Freestone. Top-bed well bored by annelids	43½	257
	11. Pea-Grit. Limestone, bluish, pisolitic	35½	292½
	Non-sequence. Lower Limestone, Scissum and Opaliniforme Beds, wanting.		
Upper Lias	12. Cephalopod Bed. Yellowish-brown, ironshot, marly limestone	6	298½
	13. Cotteswold Sands. The upper 17 ft. are greyer and more compact than the lower deposits penetrated	54½	353

Bottom of borehole 24 ft. 6 in. below O.D.

Kemerton—Maps: 199, 200, 216, 217; [44]; (5 S.E., 12 N.E.)

Kemerton village is supplied by an undertaking belonging to the Tewkesbury Rural District Council. The source of supply consists of springs situate 1¼ miles north-north-east of Kemerton Church. They issue from amid much disturbed yellow Inferior Oolite limestone and are thrown out by the Upper Lias clay. There is a chamber at the main spring head, collecting tanks, and, lower down, a service reservoir. The water of the public supply is good; hardness, 14°. It is laid on to the houses.

Kemerton Castle, C. H. C. Shorland, Surveyor, Tewkesbury Rural District Council, informs me, is supplied from the Overbury estate, from near the late keeper's cottage.

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[3] Rock specimens
(1) from 62 ft. down.
(2) ,, 75 ft. ,,
(3) ,, 82 ft. ,,
(4) ,, 91 ft. ,,
(5) ,, 97½ ft. ,,
(6) ,, 105½ ft. ,,
(7) ,, 106 ft. ,,

[4] and
(8) ,, 134½ ft. ,,

have been labelled as to the depths from which they were obtained and placed in the Cheltenham Town Museum.

Kempley—Maps : 215, 216 ; [43 N.E.] ; (9 S.E., 16 N.E.)

Kempley parish, for the most part on Old Red Sandstone, is dependent on wells, on an average about 30 ft. deep, which yield a plentiful supply.

Kempsford—Maps : 235, 252 ; [34] ; (52 S.E., 53 S.W., 60 N.E., 61 N.W.)

The village of Kempsford is on gravel, up to 10 ft. thick, resting on Oxford Clay, and is dependent on wells sunk in the gravel, several of which ran dry in 1921. It is said that water fails sooner around the church, in the vicinity of which it is necessary to go deeper to reach it. At the bottom (north-western) end of the village the gravel is thinner, and the 'Village Spring,' which has never been known to fail, issues therefrom and is caught in a dip well fitted with a lid. There are similar springs at Horcott Hill, Dunfield and Reevey.

H. A. Northen informs me that his supply at Reevey is derived from a spring, issuing from the gravel, that has not been known to fail. It flows into a catch-pit, about 8 ft. deep, holding 4,000 gallons, from which it is pumped to the water-tower (6,000 gallons), from which it gravitates to the house and farm-buildings. Some three cottages here obtain their water from a dip well in the gravel.

Whelford is on gravel resting on Oxford Clay and obtains its water from wells sunk into the gravel. Dudgrove Farm is supplied from a well (in alluvium) near the Thames.

Kingscote—Maps : 251 ; [34, 35] ; (57 N.W., S.W., N.E., S.E.)

Kingscote village is the highest in the Tetbury Rural district. It draws its supply from wells sunk in the Great Oolite and from springs thrown out by the Fullers' Earth. There is a spring near the church, and one by the side of the road on the way to Hazelcote Farm, which, T. V. H. Davison informed me, floods the road at times. In the drought of 1921 all the ponds dried up and water had to be pumped and carted for the cattle.

Kings Stanley—Maps : 234 ; [34, 35] ; (49 N.W., N.E.)

Kings Stanley village is on Lower Lias clay.

Middle Yard, Kings Stanley, is supplied with water from three sources, namely, the Stroud Water Company's mains, from a spring in 'The Combs' (as the comb between Pen and Selsley Hills is called), and Coldwell. The waters from The Combs Spring and Coldwell are piped to Middle Yard. The Borough is mainly supplied by the Stroud Water Company. There is a village pump which supplies about twenty houses. The stream running through the village coming from Huntley's Spring is polluted by drainage.

Kingswood (near Wotton-under-Edge)—Maps : 251 ; [35] ; (56 S.W., S.E., 64 N.W., N.E., S.W., S.E.)

The public supply of Kingswood (Dursley R.D.C.) is derived from a spring, the average daily yield of which, W. Webb informs me, is 15,000 gallons, at Sinwell, just under 1¼ miles north-east by east of Kingswood Church. The spring is thrown out by the Upper Lias clay, is collected in a reservoir (6,000 gallons) at Sinwell, whence it is piped to 74 houses and 5 standposts serving some 102 houses.

W. Webb has supplied the following further particulars :—

Place	Formation	Supply	Depth of well in feet
Upper Barns Farm ...	Lower Lias	Well	Under 28
Haroldfield Farm	,,	,,	About 20
Mounteney's Farm... ...	,,	,,	10
Upper Dayhouse Farm ...	,,	,,	30
Nind Farm	,,	Kingswood Supply	
Chase Hill	,,	W. Glos. W. C.	
Highwood Farm	Rhaetic	Well	Under 20
Neathwood Farm	,,	Well[1]	60
Grange Farm	,,	Kingswood Supply	

Well at Cherryrock Farm[2].—From a well in the Lower Lias here water was obtained which proved on analysis by T. J. Herapath to be a mineral water. The rocks the well was in were :—

		Ft.
	Thin mould	
Lower Lias	Stiff clay, irony	5
	Blue Lias-stone and stiff clay impregnated with salts	20 to 30
	Dry marly clay with round smooth stones like lap-stones (in this the water rises)	15

The salts present were magnesium sulphate (129 grains in the imperial gallon), sodium sulphate (122 grains), calcium sulphate (75 grains), calcium carbonate (31 grains), and sodium chloride (60 grains). Herapath stated that "most of the springs in this neighbourhood, when sunk to a great depth, are generally inclined to be salt, and a great deal of the blue lias stone, which is plentifully met with here, is stained with iron." Presumably Herapath regarded this well as of "a great depth."

W. A. Long, of Wotton-under-Edge, informed Herapath that the water in the well rose to within 24 or 25 ft. of the surface and that its quantity was never sensibly affected either by a wet or dry season.

Lancaut—Maps : 250 ; [35] ; (54 N.W.)

This little parish of 218 acres, with a population of but ten, is dependent on wells.

Lassington—Maps : 216, 234 ; [43 S.E.] ; (25 N.W., S.W.)

The parish is entirely dependent on wells, on an average about 12 ft. deep. Boring for water in the parish would be unlikely to be attended with success.

Lechlade—Maps : 235, 252, 253 ; [34] ; (53 S.W., S.E., 61 N.W., N.E.)

Lechlade is on gravel and it is therefrom that the public supply to the town is obtained. The Waterworks (the property of the Faringdon Rural District Council) are situate in the allotment ground a little to the west of the G.W.R. Station. There are four boreholes altogether : two old ones, about 28 ft. deep, under the circular tower, not now in use ; two new ones, about 20 ft.

[1] Well for domestic purposes ; water raised by wind pump from brook for farm purposes.

[2] Herapath, T. J., *Quart. Journ. Chem. Soc.*, vol. iii, 1850, pp. 200-5. H. B. Woodward, 'Geology of East Somerset and the Bristol Coalfield' (*Mem. Geol. Surv.*), 1876, pp. 180-1, and *Quart. Journ. Geol. Soc.*, vol. xlii, 1886, p. 304.

deep, lined with tubes with an internal diameter of 2 in., 15 to 20 yds. away from the square tower, in use. The water is pumped from the boreholes to the tanks (30,000 and 10,000 gallons capacity). Water is laid on to some 279 houses and to a large number of standposts well distributed throughout the town and outskirts. There was no shortage of water in 1921, but it was cut off at stated times as a precautionary measure. The supply available in the gravel-bed is far in excess of present requirements: the trouble is that it is difficult to maintain an adequate store to meet the demand for increasing quantities.

Leckhampton—Maps: 216, 234, 235; [44]; (26 S.E., 34 N.E.)[1]

The village is supplied by wells, springs, and the Cheltenham Corporation Waterworks.

A spring thrown out by the Upper Lias clay of Leckhampton Hill furnishes the supply, provided by the Misses H. C. and C. H. Barnard, to 'Bartlow,' 'Hill Grange' and 'Rockholme.'

A well sunk in the Sandy Beds of the Middle Lias in the orchard to the south of 'Undercliff' is 31 ft. deep. G. B. Witts informed me that water was not obtained until a hard bed had been penetrated at 30 ft. down, but that then the water rose to within 13 ft. of the surface.

The Leckhampton Reservoir of the Cheltenham Corporation Waterworks is in this parish (p. 205).

Boring at Rockholme, Leckhampton Hill.—Made and communicated by Messrs. A. Wills and Sons, Bath, 1909. Messrs. Wills state:—"There was 40 ft. of clay and sand [Cotteswold Sands] above the site and up to the base of the [Inferior] Oolite, and the boring went down 250 ft. through Lias clay."

The result was unsatisfactory.

Leigh—Maps: 216; [44]; (18 S.E., 19 S.W.)

The parish is dependent on wells which yield on the whole an adequate supply of water of fair quality, but some wells ran dry during 1921. A well at the cottages at The Bowlings is about 30 ft. deep with an unfailing supply of good water reaching, in June, 1922, to within 18 ft. of the surface.

Leonard Stanley—Maps: 234; [35]; (49 N.W.)

Leonard Stanley is served by the Stroud Water Company, but there is a spring near St. Swithin's Church which may be drawn upon by anyone who wants water and there are copious springs at Seven Waters—the water from all of which springs issues from the gravel and runs to waste into the Frome.

A well at The Grange is 70 ft. deep in Lower Lias clay and yields a saline water.

Little Barrington—Maps: 235; [44]; (37 S.W., S.E., 45 N.W., N.E.)

There are two springs in Little Barrington village from which the cottagers obtain their supplies by dipping, and the Fox Inn gets its water from Cold Bath Spring.

Three miles distant in an east-south-easterly direction, in Oxfordshire, on the left bank of the brook immediately west of a plantation (geol. map 44) and between Sturt Farm and Burford Signet, is the site of the deep boring made in 1875-77 which proved[2]:—

[1] Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xviii, 1913, pt. 2, pp. 125-136. (Contains 6-inch map, sheet geologically coloured.)

[2] De Rance, C. E., *Rep. Brit. Assoc.*, Dublin, 1878, p. 384; *Trans. Manchester Geol. Soc.*, vol. xiv, p. 437; R. Etheridge, *Pop. Sci. Review*, ser. 2, vol. iii, p. 290; E. Hull, 'Geology of the Country around Cheltenham' (*Mem. Geol. Surv.*), 1857, p. 64; H. B. Woodward, 'The Jurassic Rocks of Britain,' vol. iv (*Mem. Geol. Surv.*), 1894, pp. 303, 304.

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Great Oolite	62	6	62	6
Inferior Oolite ?	27	8	90	2
Upper Lias	82	2	172	4
Middle Lias	98	1	270	5
Lower Lias	447	4	717	9
Rhaetic Beds and New Red Sandstone Series ...	466	11	1184	8
Coal Measures	226	0	1410	8

Little Dean—Maps: 233, 234; [43 S.E.]; (31 N.E., S.E.)

The village supply is derived from two wells, each 9 ft. deep, at Callamore—between Little Dean and Littledean Hill. The water is piped to a reservoir (2,000 gallons) from which it is laid on to some houses and to standposts.

Little Rissington—Maps: 217, 235; [44]; (29 S.W.)

The village is supplied by 'spout springs,' dip wells, fountain, pump and laid-on water. All the springs are thrown out by the Upper Lias clay.

The water of 'Bobble Spring,' some of which discharges into a roadside trough near the spring head, is piped to a 'spout spring' which discharges into an iron pan near the uppermost houses in the village, then on to a well, from which one pipe goes to the Chapel-house and another to the Manor Farm buildings, after which the surplus water runs to waste. A spring rising near the barn on the hillside is collected into a tank near by and supplies the fountain, pump at lower end of village, and Manor House. There are one or two wells in the lower part of the village.

A spring rising in a wood not far from, and at the same level as, the Bobble Spring, supplies a reservoir (6,000 gallons—marked on the six-inch map, 29 S.W.) from which the water is laid on to the Manor House, various farms and cottages in the central part of the village.

Numerous small springs are thrown out by the Upper Lias clay near Clark's Hill Coppice; one in the ground east of Old Green Barn; at Far Hill Barn and Cate Britain.

Little Sodbury—Maps: 251; [35]; (69 N.E., S.E.)

The village is dependent on wells and springs.

Littleton-upon-Severn—Maps: 250; [35]; (54 S.E., 62 N.E., 63 N.W.)

The parish is dependent on wells, the supply of water in which is somewhat inadequate.

Little Washbourn—Maps: 217; [44]; (13 N.W., S.W.)

The few houses constituting the village are mainly on a superficial sand-bed. The supply is obtained by pipe from a spring issuing from at or near the base of the Sandy Beds of the Middle Lias in the side of Washbourne Hill,

Longborough—Maps: 217; [44]; (21 N.E., 22 N.W., S.W.)

The village of Longborough is mainly supplied by 'Ashwell' (analysis, p. 264), which is situate below the Vicarage towards the southern end of the village. The spring water is collected into a tank, from which it is piped to six troughs in various parts of the village. The Manor Farm now has water piped from the Sezincote supply; but Middle Farm from 'Ashwell.'

Banks Fee is supplied from near Waterhead Barn (p. 81), where a windmill pumps water to a reservoir near the Stow road. Ganborough House has a well through Inferior Oolite (90 to 95 ft. to water), and so has the Coach and Horses Inn (about 100 ft. to water).

At Luckley Farm is a spring thrown out by a Great Oolite clay-bed (probably the Marly Beds), the domestic supply being drawn from a shallow catch-well fitted with a pump in a pump-house.

Longford—Maps: 216, 234; [43 S.E., 44]; (25 S.W., S.E.)

Out of the 130 houses in the parish 19 are supplied with Gloucester Corporation water: those not so supplied are dependent on wells.

Longhope—Maps: 216, 234; [43 S.E.]; (23 N.E., S.E., 24 N.W., S.W., 31 N.E., 32 N.W.)

Longhope village, on the red marls near the base of the Old Red Sandstone, is dependent on wells—some dip-wells catching springs. By the roadside at Dan Barn Cottages, between the village and the church, is a brick and cement-lined dip-well catching a spring coming from the direction of Bradley Court. In Longhope, near Wallbrook House, spring water has been laid on to a horse trough.

At 'The Royal Spring House,' Little London, a good spring (Royal Spring) runs through a pipe into a dip-well (about 355 ft. above O.D.) and constitutes the usual source of the Ley Brook. The water supplying it collects in a depression in the Wenlock Shales.

Long Marston—Maps: 200; [54 S.E.]; (3 N.E., S.E., 4 N.W., S.W.)

This parish is on the Lower Lias. The village is connected with the mains of the Evesham and Pebworth Villages Joint Water Committee's Supply.

Longney—Maps: 234; [43 S.E.]; (32 N.E., S.E.)

The village, partly on clay and partly on gravel, is supplied by wells, from 15 to 25 ft. deep.

Lower Lemington—Maps: 217; [44]; (15 N.E., S.W., S.E.)

Lower Lemington is supplied by an undertaking that was provided by Lord Redesdale. John Kennedy, formerly Agent to the Batsford Estate, informed me that the source of supply is a spring in Plains Coppice. The water is pumped up by a ram to a reservoir (8,000 gallons) from which it is piped to Lemington Manor and Lemington Grange Farm and to standposts in the village. Mr. Kennedy thinks that 30,000 to 40,000 gallons a day run to waste from the spring. A well supplies Lower Lemington House.

A boring for coal at Lower Lemington[1] was made in 1901-1904 350 yds. W. 22°N. of Lower Lemington Church.

According to Mr. Kennedy "boring operations were stopped for some days by reason of the force of water found" (29th April, 1921).

Lower Slaughter—Maps: 217; [44]; (28 N.E., S.E., 29 N.W.)

There is no public supply. The supply belonging to Mr. Whitmore is derived from three or four springs thrown out by the Upper Lias clay. They are collected by pipes into a reservoir whence the water gravitates, the main being tapped *en route* for a supply to the lawn at the Manor House. Here there is a division: one pipe supplies the Manor House, the other the fountain on the village green, the school and one or two houses. The chief of the three or four springs referred to is called King's Well. It is caught in a tank by the road-side (north) ⅜ mile south-west of the church. The top of the village is supplied by an undertaking belonging to Col. Brassy. A spring issuing from

[1] Strahan, Sir Aubrey, 'Summary of Progress' for 1912 (*Mem. Geol. Surv.*), 1913, pp. 90-91.

slipped Inferior Oolite freestone near 'Wilkins' Barn' ($\frac{3}{8}$ mile W. of the church) feeds a standpost and is laid on to the mill, a cottage close by, and bakehouse.

Copse Hill House is supplied from a catch-pit in the gravel in the park.

Glebe Land Spring, Slaughter Farm. See Bourton-on-the-Water, p. 61.

Lower Swell—Maps: 217; [44]; (21 S.E., 22 S.W., 29 N.W.)

The village of Lower Swell (with the exception of a few houses which are on the Cotteswold Sands), Abbotswood House and Bowl Farm are supplied by undertakings provided by M. Fenwick of Abbotswood House. Abbotswood House is supplied by a spring thrown out by the Upper Lias clay some 150 yds. north-east by north of the House. The village and Swell Buildings are supplied from a strong, deep-seated spring which has been tapped and the water raised by rams at the Pumping House immediately west of the village. The supply is abundant.

Spa Cottages are by the side of the road from the village to Stow-on-the-Wold. On one is an oval stone tablet with the inscription "Carbonated Chalybeate, discovered 1807." In the cellar is a well (nearly dry in March, 1922) tapping water arising from the Marlstone, but it is not now used. An account of the Spa, by the writer, appeared in 1927.[1]

Lady's Well is a spring close to the lower lodge of Abbotswood House.

At Chalk Hill numerous springs are thrown out by the Fullers' Earth. From the spring west of The Lodge water is piped to Swell Wold Farm, and supplies, *en route*, The Lodge and, by a tap by the roadside, Swell Wold Cottages. At the spring, about 150 yds. to the south-east, is a pump-house at which water was raised, by pumps operated by a horse, to Eyford Hill, but this source of supply to the farm has been disused since J. C. Cheetham, of Eyford Park, supplied the farm from his own reservoir (p. 92). About 150 yds. east of the old pump-house another spring maintains a pond. Water from all three sources runs into Pumphouse Covert and into a streamlet that flows down the valley in an easterly direction. Usually before the streamlet reaches the bottom of the valley coming down from Swell Wold Farm way its waters sink into the ground.

Lydney—Maps: 233, 234, 250, 251: [35, 43 S.E.]; (39 S.W., S.E., 47 N.W., N.E., S.W., S.E.)

The public supply (Lydney Rural District Council) to Lydney is obtained from 'Ferney Wood,' near Aylburton Common, 2 miles west 2° south of Lydney Church where an adit is driven into the Old Red Sandstone. The water is pumped to a covered reservoir (180,000 gallons), just above Lodge Farm, $\frac{1}{2}$ mile to the N.E. by N.

Maisemore—Maps: 216, 234; [43 N.E., S.E.]; (25 N.W., S.W.)

The village is dependent on wells sunk into the gravel. Maisemore Park is supplied from a well at the bottom of the hill on the Alluvium, $\frac{1}{4}$ mile north of the house. The water is pumped to a tank with filter at Maisemore Park Farm. The houses $\frac{1}{2}$ mile north-west of the church have shallow wells sunk into the gravel. Spring Hill and Woodgate Farms and the houses about $1\frac{1}{2}$ miles north-north-west of the church have a piped supply from a reliable spring from gravel on Lower Lias at Springhill fields. The water is collected on the west side of the road and pumped to a 3,000 gallon reservoir with filter. Until 1921, a ram was in operation in Maisemore Wood, on the lower slopes and east of Woolridge Hill. This source supplied the Spring Hill Farm district and troughs in the fields near the summit of Woolridge Hill from which people living near fetched their supplies. Since the ram has stopped working these people have had to depend on the pre-existing wells.[2]

[1] *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 3 for 1926 (1927), p. 261; *idem* vol. xxi, pt. 2 for 1922 (1923), p. 75.

[2] I am indebted to R. C. S. Walters for the above information.

Mangotsfield—Maps: 264, 265; [35]; (72 N.E., S.E.)

Out of the 2,709 houses, 2,150 are supplied by the West Gloucestershire Water Company; those not so supplied are dependent on wells.

The section proved in Mangotsfield Pit is described by H. B. Woodward.[1]

Marshfield—Maps: 265; [35]; (73 S.E., 74 N.W., S.W., 77 N.E., 78 N.W.)

The northern head-streamlet of the Broadmead Brook rises at Broadleaze Spring (about 630 ft. above O.D.) and is contributed to by Oxleaze Spring, issuing from the base of the Great Oolite about the same altitude. Further down it receives waters from springs at Springs Farm (or 'Weatherwell Barn') near Cadwell Hill Barn, and north of Westend Town Green. Near the bridge over the Broadmead Brook (near the B.M. 482·4) between Castle and Cadwellhill Farms would be a good collecting-place for water and probably for boring.

Bulls Hill, Holly, Beck's and Hop House Springs issue from the base of the Cotteswold Sands in the southern portion of the parish and from part of the supply of the Bath Corporation's Waterworks.

Marshfield is dependent on wells, which held out during the drought of 1921, sunk into the Great Oolite.

The Rocks, Marshfield, is supplied from a spring at Hop House Cottage.

Bath Corporation Waterworks.[2]—The Bath Corporation obtains a considerable quantity of the water for its public supply from valleys in the extreme southern end of the South Cotteswolds. The water issues in the form of numerous springs from two horizons—(1) from the basement beds of the Great Oolite, and (2) from the base of the Cotteswold Sands. The spring-waters are collected and conveyed to two reservoirs, the Monkswood Reservoir and the Oakford Service Reservoir. The water is said by the analyst to be "in every respect satisfactory," to have "no action on lead," the hardness of that from Monkswood to be 21°, and that from Oakford, 21·5°.

Monkswood Reservoir.—Situated in a western comb of the St. Catherine's Valley.

Capacity, 51,000,000 gallons: depth at embankment, 35 ft.: water area, 9 acres. Height of top water-level above O.D., 360 ft. Fed by springs breaking out at two levels:—(1) At the top of the Fullers' Earth. These are (*a*) On the northern edge of Charmy Down (Somerset) to the south of the reservoir. They are close together and just above the 600-ft. contour. Their yield varies considerably. They sometimes yield a million gallons a day, but in the dry period of July, 1921, were yielding only about 16,000 gallons. (*b*) Holts Down Springs (Somerset) situated about 530 ft. above O.D. yield over 200,000 gallons a day in wet weather, but in the dry period of July, 1921, were yielding only about 2,600 gallons. They are taken directly into the Monkswood Main. (2) At the base of the Cotteswold Sands. These springs, all in Gloucestershire, break out a little above the 400-ft. contour, and are:—(*a*) Monkswood Spring, up the comb to the south-west of the reservoir; (*b*) Little Monkswood Springs (two) immediately to the north of the reservoir; (*c*) The Whiteway Springs (six) up the comb running in the direction of Cold Ashton; (*d*) fourteen springs up the main valley in which is situated "Moody's" (geological map, Sheet 35, old ser.) and (*e*) Beck's Common Springs. These lower springs are more permanent than the upper, although their yield varies from 3,100,000 gallons to 379,000 gallons a day in dry periods.

According to the geological map, Monkswood Reservoir is situated immediately below the Midford or Cotteswold Sands on the Middle Lias, but according to the late Rev. H. H. Winwood on the Lower Lias.[3]

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[1] 'Geology of East Somerset and the Bristol Coal-Fields (*Mem. Geol. Surv*), p. 38.

[2] Full particulars of these Waterworks are given in 'Wells and Springs of Somerset' (*Mem. Geol. Surv.*), 1928, pp. 198-200.

[3] *Proc. Bath. Nat. Hist. and Antiq. F. C.*, vol. viii, 1895, pp. 150, 151.

Winwood found that this valley was floored with a lacustrine deposit and gives the following section:

	Ft.
" 1. Top soil, grass and yellow sandy clay	1
2. Peaty deposit and white marly wash (more peat than marl)	1 to 1½
3. A succession of loops of marl and peat, becoming more marly at base, with wood and land and fresh water shells near the top	20
Resting on—	
4. Blue Lias clay, greyish on top, becoming bluer at base	— "

Oakford Reservoir.—Situated near Oakford Farm, ½ mile east-south-east of St. Catherine's Church; for collecting the various groups of springs in this system.

Capacity, 500,000 gallons. The water gravitates from this reservoir to a small service reservoir in Bath. Fed by springs which are situated:—(*a*) near the head of the comb that lies between Ayford Farm and Longley Wood, a little below the 400-ft. contour (two springs); (*b*) Ayford Spring, on the east side of the road about 120 yds. west of Ayford Mill a little below the 300-ft coutour (one); (*c*) Drummond's Springs (two), in Somerset, up the comb to the west of St. Catherine's Church a little below the 300-ft. contour; (*d*) near or alongside Oakford Lane (twelve), one, the farthest up the valley being between the 300- and 400-ft. contour and the remainder between 225 and 300 ft. above O.D.; (*e*) County Boundary Springs (four) up the valley about a third of a mile to the south-south-east of the Oakford Reservoir; (*f*) Wayfield Springs (three) to the west-by-south of Batheaston Church. According to Jules Dent Young the above springs are all the lower or permanent springs, " thrown out by the Liassic clays." Their total yield varies from 1,100,000 gallons a day in the wet weather to 321,000 gallons a day in the dry weather.

Matson—Maps: 234; [44]; (33 N.E., S.E.)

Numerous small springs issue from the Sandy Beds of the Middle Lias and some are collected into a reservoir in the field south of the church and thence into the main reservoirs of the Gloucester Corporation.

One house out of 15 in the parish has Gloucester Corporation water laid on: wells and springs are the main source of supply. Thus Matson House is supplied from a well near the church and Larkham Farm from a spring.

'Red Well' is situate in a field called 'Red Well Ground.' The water feeding it, which is still held locally to be 'good for the eyesight,' is very ferruginous and is said to be piped from a spring issuing in the neighbourhood of the Marlstone in Matson Wood. The overflow is received into a semi-circular stone basin adjoining the well and the overflow from it is piped to a trough by the road side (analysis, p. 265).[1]

Maugersbury—Maps: 217; [44]; (22 S.W., 29 N.W.)

The Manor and village of Maugersbury are supplied by an undertaking that was provided by the late J. H. Hewitt of the Manor House. The supply consists of springs thrown out by the Upper Lias clay on Margerry Hill, which is about a quarter of a mile from Stow Station on the Maugersbury side of the railway. There are tanks at Maugersbury ((*a*) 8,000 gallons; (*b*) 2,600 gallons) and the Manor House (5,000 gallons). The daily average quantity of water supplied is 2,500 gallons and the supply is constant. There is no filtration and the quality is satisfactory.

St. Edward's Well, ⅜ mile north of Stow-on-the-Wold Station rises in a faulted tract, the water being thrown out by the Upper Lias clay.

[1] See *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), pp. 85, 86, and pl. ii, fig. 2.

Meysey Hampton—Maps: 235, 252; [34]; (52 N.W., S.W., N.E., S.E., 60 N.W, N.E.)

Meysey Hampton village is for the most part dependent on wells sunk into the gravel. The majority are from 8 to 16 ft. deep: those on the west side of the village give out before those on the east and the 8- to 10-ft. wells failed to yield a proper supply in 1921. A well in School Lane is 16 ft. deep. The lower part of the village makes good use of a strong perennial spring, issuing from the gravel, on the Village Green. There is a dip well at the spring head, and a strong overflow feeds a trough and then a 500-gallon tank near by. The overflow from this spring is also piped to a 2,000-gallon underground tank at the cottage below, from which the water is pumped to a tank at "Villars" whence it gravitates to the house and farm-buildings. There is also a spring under "Villars," the water from which is piped to the 2,000-gallon tank. Water from a well, 14 to 15 ft. deep in gravel, at the Manor House is raised to a tank in the roof; and from a well, about the same depth, at Hill House, to a 1,000 gallon tank in the roof.

At South Hill Farm there are three wells in gravel and one at an adjoining cottage, but all gave out during the drought of 1921.

Sunhill is provided for from the Hartwell supply.

For Hartwell, see Poulton, p. 135.

Meysey Hampton Borehole.—About 300 yds. S.E. by E. of Field Barn and about 1,400 yds. N.N.E. of Meysey Hampton Church.

Made in 1922 for Messrs. R. W. Hobbs and Sons (to supply some new farm buildings), and particulars communicated by H. J. Godwin of Quenington, Fairford.

Surface-level.—About 351 ft. above O.D.

Borehole (punched):—		Thickness Ft.	Depth Ft.
[Cornbrash[1]]	1. Stone	2½	2½
[Forest Marble]	2. Clay	9	11½
	3. Grey stone	7	18½
	4. Blue marl	4	22½
	5. Blue stone	3	25½
	6. Blue clay	5	30½
	7. Stone	1	31½
	8. Clay	4	35½
	9. Stone	6	41½
	10. Clay	1	42½
	11. Stone and clay beds ...	9½	52
[Great Oolite]	12. White stone (rest-level of water)	4	56
	13. Blue stone (very hard) ...	16	72
	14. Marl	3	75
	15. Blue stone	26	101
	16. Grey stone	10	111
	17. Clay	1	112
	18. Blue stone	13	125
	19. White stone	7	132
	20. Clay	1	133
	21. Blue stone	10	143
	22. Clay	1	144
	23. Blue stone	7	151
	24. White stone (struck good supply)	5	156

Yield.—On 20th November, 1922, approximately 6,300 gallons of water were pumped out without drawing air in 9 hours.

[1] The classification is approximate.

Mickleton—Maps: 200; [44, 54 S.E.]; (3 S.E., 4 S.W., 7 N.E., S.E., 8 N.W., S.W.)

The village of Mickleton is situate, with the exception of a few houses at its extreme north-eastern end, on a superficial sand-bed, and nearly every cottage has a well from 8 to 12 ft. deep. The water-level, however, varies considerably.

The water in the sand-bed was adequate for the village in its earlier days, but not when the village grew. Moreover the well-waters were liable to become polluted.

A supply for the village was provided by the late S. G. Hamilton, the source of supply being a spring issuing from the Middle Lias up the valley in Mickleton Hill to the south-south-west of the village. Recently water from a spring (which when gauged in March, 1924, gave 50,000 gallons) thrown out from the Inferior Oolite by the Upper Lias clay on Ebrington Hill Farm has been added to the supply. The water is collected into a reservoir (10,000 gallons) (analysis, p. 265), and supplies twelve houses and three fountains.

A number of springs issue from at or near the base of the Sandy Beds in the neighbourhood of the 400-ft. contour. Such springs are those rising in the grounds of Norton House; that on the outskirts of Carter's Leys Coppice, which is the source of the Norton Brook; and those all along the hill-slope below Baker's Hill, Mickleton (in the extreme south-western portion of which rises Gran Brook), and Clopton Woods. At places the water is tapped by wells. J. M. Dixon informs me that "three of the market gardens have pipe supplies from this horizon at the base of the escarpment running north-north-east from Kiftsgate Court and two or three farms below the scarp are also so supplied."

Mickleton Boring.[1]—Situated in the field to the east of Mickleton Wood, 500 yds. north-east by east of Kiftsgate Court. Surface-level, about 598 ft. above O.D. Made for the late S. G. Hamilton and communicated by Messrs. Le Grand and Sutcliff. Commenced, December, 1889; finished, December, 1892.

	Thickness Ft.
Middle Lias	280
Lower Lias	961
Rhaetic	74
Keuper Marl	27
Total	1,342

This boring was originally undertaken with the object of finding water, but when no supply was obtained, S. G. Hamilton had it continued as a scientific enterprise. It was, however, abandoned soon after the Keuper Marl was reached, but it proved that the Lower Lias was thicker here than anywhere else in this country, so far as is at present known.

Minchinhampton—Maps: 234, 251; [34]; (49 N.E., S.E., 50 N.W., S.W.)

Minchinhampton is now mainly supplied by the Stroud Water Company from their high-level reservoir on the Common; but there are a few wells in use, and Well Hill Spring, which is thrown out by the Fullers' Earth, is also drawn on. In times past Minchinhampton was dependent partly on wells and partly on Well Hill Spring. The Great Oolite is rent by more or less vertical fissures, locally called 'lissens' or 'lizens,' through which rainwater quickly finds its way to the Fullers' Earth. The late A. T. Playne wrote:—

[1] See 'The Jurassic Rocks of Britain,' vol. iii (*Mem. Geol. Surv.*), 1893, pp. 156-157.

"These 'lizens' have from time immemorial been largely used for drainage purposes, for which they were very convenient, thereby doing away with all necessity for an expensive system of drainage. Any liquid, however contaminated, was turned into a 'lizen,' and when out of sight was soon out of mind. Fortunately this system of drainage is now made illegal by the bye-laws recently adopted by the Rural District Council. But at the time of the Minchinhampton epidemic [of typhoid fever in 1844] it was an almost universal practice and it is wonderful that there is no record of any previous epidemic having occurred in the town except a small one in 1758."[1]

Hampton Fields and House are supplied by the Stroud Water Company. Gatcombe Park is supplied by spring. Bubblewell (Forwood), springs thrown out by the Fullers' Earth, is used by those living in the vicinity. Four or five springs (strong ones) rising in the neighbourhood of the B.M. 518·0 above Springfield used to supply Forwood Brewery and the overflow went into a trough by the side of the road to Minchinhampton.

Box is supplied by the Stroud Water Company, and by Troublewell Spring which furnishes a good supply. At Box Farm is a deep well which was originally a shaft sunk by the United Stone Firms Ltd.

Boring at Mount Pleasant, Box.—Made in Jan. and Feb., 1928, for Wilfrid Mathieson in Field No. 625, 25-in. Ord. Surv. Map, Glos. xlii, 5. Particulars communicated by Mr. Mathieson.

Boring (diameter 6 in.) :—

		Thickness Ft.	Depth Ft.
	Gravelly soil	13	13
[Inferior Oolite]	Oolite	17	30
	Pea Grit [Series]. Extremely hard	70	100
[Upper Lias—Cotteswold Sands]	Yellow sand and clay with sandy stones and blue-white stones ...	25	125

Water encountered at about 118 ft. down : present water-level (26th Feb., 1928) 105 ft. down.

Amberley and Littleworth are now mainly supplied by the Stroud Water Company. Spriggs Well, near Rose Cottage, Amberley, used to furnish the supply for the ancient camp.

Burleigh, on the Fullers' Earth, is supplied by the Stroud Water Company, but a spring in the hamlet is largely used.

In the Golden Valley a large number of springs—the Chalford Springs of literature—issue from the base of the Cotteswold Sands, the chief of which are 'The Bubbler,' 'The Black Gutter,' and the spring which is the main source of the Stroud Water Company's supply at Clerk's Mill.

'The Black Gutter,' Lewis Grist informs me, is the biggest feeder of the Thames and Severn Canal and is fed by about twenty springs rising under the railway-bank. The water readily parts with its carbonate of lime : G. F. Playne noticed a large deposit of tufa made by the springs.[2] Probably the 'boiling up' of 'The Bubbler' (about 270 ft. above O.D.) is due to artificial causes.

In connexion with the outburst of so much water on the south side of the valley the section prepared by H. G. Dines and given on p. 16 of this memoir is of special interest.

Stroud Water Company.

Supplies Nailsworth U.D. (which includes Forestgreen, Newmarket, Rockness Hill and Walkley Wood) ; and parts of the parishes of Cainscross,

[1] 'A History of the Parishes of Minchinhampton & Avening' Gloucester, 1915, p. 61.

[2] *Proc. Cotteswold Nat. F. C.*, vol. vi, pt. 2 for 1872-73 (1874), p. 82.

Chalford, Ebley, Horsley, King's Stanley, Leonard Stanley, Minchinhampton (which includes Amberley), Painswick, Pitchcombe, Rodborough (including King's Court), Stonehouse, Thrupp (including Brimscombe), Whiteshill, North and South Woodchester (Stroud); Eastington and Frocester (Wheatenhurst R. D.).

Powers.—Stroud Water Act, 1882.

Limits.—The above, Avening (Tetbury R.D.), Bisley-with-Lypiatt and Randwick (Stroud R.D.).

Under the Stroud Water Act, clause 48, the Stroud U. D. C. have the right to supplement their supply to the extent of 100,000 gallons per day from the low level reservoir at the main Pumping Station; but if the Council shall require on any one day more than 100,000 gallons they shall give the Company 14 days previous notice in writing, and in such case they shall be bound to continue to take not less than 100,000 gallons for not less than 14 consecutive days, and must give 7 days notice before discontinuing such extra supply.

Sources of Supply.—(1) Clerk's Flour Mill Spring (main supply); (2) springs at Bliss Mills; (3) Pumping Station in valley at Chalford (standby).

Clerk's Four Mill Spring comes out of the south side of the valley and is conducted through a culvert to a pumping-sump beside the mill-pond. Into this sump discharges water brought through an 8-in. pipe from the Bliss Mill springs (see below). About 30,000 gallons per hour are pumped from this sump and there is an overflow into the mill-pond of about 1,000,000 gallons per day. There is another spring which is not now used, also coming out of the south side of the valley, and discharging direct through an earthenware pipe into the millpond close to the pumping-sump. The overflow from the 'Black Gutter' is conveyed by an iron pipe and discharges into the millpond alongside the earthenware pipe.

At Bliss Mills are a number of springs. The water of the main one is conveyed through the 8-in. pipe mentioned above to the Clerk's Mill pumping-sump, and a few yards below (down the valley) the water of a second spring is collected and taken into the 8-in. pipe by a branch pipe.

The average yield of the springs used by the Company is 1,500,000 gallons per day.

The Pumping Station higher up the valley at Chalford has not been used for some years as the supply from the wells—about 80 ft. deep with headings—was soon decreased by the pumping necessary to meet the demand and it fell off rapidly in dry periods. It is estimated that 200,000 gallons per day is available from this source if ever required.

Works.—The water is pumped to service reservoirs on Minchinhampton Common ((*a*) 1,000,000 gallons; (*b*) 4,500,000 gallons), and Painswick (1,000,000 gallons). There are local service reservoirs (concrete tanks) at Nailsworth and Horsley.

Analyses, p. 266.

Minsterworth—Maps: 234; [43 S.E.]; (25 S.W., 32 N.E., 33 N.W.)

Village and parish are dependent on wells which yield an adequate supply. The drought of 1921, however, reduced the quantity of water in the wells.

Miserden—Maps: 234; [44]; (42 N.W., N.E., S.E.)

Miserden village is supplied by an undertaking provided, about 1920, by F. N. H. Wills. The source of supply is a spring thrown out by the Fullers' Earth towards the top of the steep valley side facing Bull Banks Common. For other than potable purposes Miserden Park and gardens are supplied with water forced up by rams from the lake in the Park.

Before the present supply was installed the village obtained its water mainly from a spring in the bank east of the church.

Sudgrove obtains its water from a spring thrown out by the Fullers' Earth that has never been known to fail. Water from this source is piped to a small reservoir over the wall in the garden to supply Warmford House. A streamlet springing from near Sudgrove House has water pumped from it to Sudgrove House. Sudgrove Farm and fields are supplied by a spring in 'Brock's Orchard.'

The cluster of houses called 'The Camp' is dependent on a village well and rain-water. This well is 48 ft. deep, through Great Oolite, dry-steined, and on May 27th, 1922, had 4 ft. of water in it.

At Overtown there are springs thrown out by the Fullers' Earth, one of which supplies the farm and buildings.

Mitcheldean—Maps: 233, 234; [43 S.E.]; (23 S.E.)

Mitcheldean has a population of about 500. It is supplied by an undertaking owned by the Mitcheldean Waterworks Co., Ltd. The source of supply is a spring in Scully Grove above the Cement Works, which, according to Wm. Whitehouse, Surveyor and Waterworks Engineer, of East Dean and United Parishes Rural District Council, "appears to be just on the edge of the limestone crop, so it is probable that the bulk of the water comes from that formation." The water is tapped at its source, piped to a reservoir (11,000 gallons) on the works premises, from which it gravitates to Mitcheldean, in which it is laid on to a number of houses and to standposts. The Company is for the most part controlled by the Forest Brewery, which is said to take about 75 per cent. of the water; but under normal conditions the quantity available for Mitcheldean is adequate. In 1922 a ram was installed at the spring by the brookside in the valley between Barton Hill Quarry and the disused Wilderness Brick Works to force the water up to the brewery for washing purposes and so supplement the waterworks supply.

There are a few wells, sunk in the Old Red Sandstone, in Mitcheldean, but the majority went dry during the drought of 1921.

Borings for the Wigpool Coal and Iron Syndicate.—Made and communicated by Messrs. C. Isler & Co., Ltd. No. 1.—1923. No. 2.—1923-24.

	Thickness Ft.	Depth Ft.
Boring No. 1:—		
Mould	1	1
Variegated Loam	3	4
Sandstone	10	14
Red marl	3	17
Sandstone	5	22
Red marl	12	34
Sandstone	4	38
Red marl	9	47
Blue shale	3	50
Red marl	7	57
Sandstone	5	62
Red and grey marl	22	84
Grey marl	16	100
Red and grey marl	57	157
Red sandstone	6	163
Boring No. 2:—		
Mould	1	1
Sandstone	2	3
Variegated loam	3	6
Sandstone	8	14
Red and grey marl	15	29
Red sandstone	16	45

	Thickness Ft.	Depth Ft.
Red marl	1	46
Sandstone	3	49
Red marl	5	54
Shale	6	60
Sandstone	9	69
Red and grey marl	15	84
Shale	1	85
Grey stone	3	88
Shale	3	91
Sandstone	10	101
Red and grey marl	14	115
Grey stone	7	122
Red and grey marl	5	127
Shale	2	129
Sandstone	6	135
Red marl	2	137
Sandstone	7	144
Grey stone	8	152
Red and grey marl	21	173
Shale	2	175
Grey stone	3	178
Red marl	2	180
Shale	7	187
Red marl	5	192
Grey stone	11	203
Shale	16	219
Grey stone	3	222
Shale	2	224
Marl	2	226
Shale	12	238
Grey stone	3	241
Shale	5	246
Grey stone	8	254
Shale	13½	267½

Moreton in Marsh—Maps: 217; [44]; (15 S.W., S.E., 22 N.W., N.E.)

Previous to the provision of a public supply, Moreton in Marsh was dependent on wells sunk through Boulder Clay into Glacial gravel, but the water in the majority of them was polluted.

The public supply is provided by the Chipping Campden R.D.C. and is obtained from springs thrown out by the Upper Lias clay at Upper Swell Mill, Upper Swell. The springs are the property of M. Fenwick of Abbotswood, Lower Swell. The water is pumped to a reservoir at Donnington (capacity 20,000 gallons). An average of 12,000 gallons a day is taken from the Upper Swell springs and an unlimited quantity of water remains. The total hardness of the water is 14·22°; permanent, 4·68°. The water has no plumbo-solvent action.[1]

Moreton Valence—Maps: 234; [43 S.E.]; (40 N.E.)

This parish is on Lower Lias clay and is supplied by wells, 20 to 30 ft. deep, but A. J. Mugliston, Sanitary Inspector to the Wheatenhurst R.D.C., informs me that owing to there not being a sufficient number of wells locally, some

[1] The history of the search for a suitable supply of water for Moreton in Marsh can be obtained from "Moreton Water Supply. Report of Inquiry held by Col. W. Langton Cole, M.Inst.C.E. (Local Government Board Inspector) on 21st January, 1903, at the Mann Institute, Moreton in Marsh."

people have to boil brook-water for drinking purposes. He also informs me that the quality of the well water as a whole is fairly good.

Naunton—Maps: 217; [44]; (28 N.W., S.W., N.E., S.E.)

Naunton village is supplied by springs issuing from at or near the base of the Cotteswold Sands. A spring on a fault line in a field west of the Grange Hill road and some 200 yds. north of the church is collected into a reservoir by the side of the road about 110 yds. south of the church. Thence the water gravitates to standposts in the western part of the village. The lower-lying eastern part of the village is served by standposts fed by springs which 'boil up' and are collected in a well in the grounds of the Manor Farm. A spring issuing from the base of the Cotteswold Sands by the wall immediately west of the bungalow on the north side of the by-road to Summerhill supplies Longford Farm, and, when there is an overflow, a standpost in the village, and the bungalow itself. The supply for the village is adequate and does not fail.

About ½ mile S.E. of Harford Bridge, where the Cotteswold Sands make their appearance again, are the local Seven Springs. By a scheme carried out for Col. E. P. Brassey, water from these springs is pumped to a reservoir (about 30,000 gallons) in "Petty Holt," near Wales Farm, whence it gravitates to supply Harford Hill farm-buildings, Wales Farm, Glebe Farm, Model Farm, Upper Slaughter village, Upper Slaughter Manor House, and Pensehill.

Newent—Maps: 216; [43 N.E., S.E.]; (16 S.E., 17, 24 N.W., S.W., S.E.)

At Boulsdon, where the coal was discovered and first worked in 1790, the six shafts, which were sunk and had depths varying from 189 to 240 ft., had to be abandoned owing to the great influx of water.[1] William Smith noted in 1805 particulars of the beds passed through in "Bowsdon Coalwork, 1 mile S.W. of Newent," which were published by Prof. J. Phillips in his 'Memoirs of William Smith, LL.D.' (1844, p. 58).

Some 150 houses at Newent, which is on Keuper Sandstone, have Gloucester Corporation water laid on from the Pumping Station; but there are a few wells from 10 to 80 ft. deep, the water in which is generally good.

The houses at Cliffords Mesne are dependent on wells the supply of water in which is on the whole adequate, but there are cases of individual shortage in which the inhabitants have to use water from the brook that rises near Mayhill Cottage.

A well between Great Boulsdon and Boulsdon Croft penetrated Coal Measures and yielded a water that contained sulphuretted hydrogen.

Newent Spa.[2]—Newent Spa was situate ½ mile east-north-east of Newent Church between Hill Top and the Ell Brook on grounds now belonging to W. F. Beckett of Newtown, Newent. The well of the Spa is still in existence in the level alluvial ground bordering the Ell Brook, but was covered over a few years ago owing to the trouble occasioned by people coming to drink the water. The overflow from the well, for it is a spring that feeds it, is now piped into the brook a few yards west of the pier of a demolished foot-bridge that was erected for the convenience of visitors to the Spa. The sample of water, of which the analysis is given on p. 267, was obtained from the outfall of this pipe. W. F. Beckett informed Cecil Duncan that he considers the water to be more highly charged with mineral matter in the months of April and May.

From the sample of water analysed (p. 267) there was an entire absence of sulphuretted hydrogen. The Newent water when compared with the

[1] Murchison, R. I., *Silurian System*, 4to London, 1839, p. 154.

[2] For a full account of the Spa see C. Duncan and L. Richardson, *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), pp. 153-156.

Pauntley water contains less sulphates and considerably less common salt. Free and saline ammonia is distinctly high, whereas the albuminoid ammonia is by no means excessive. There is no evidence of animal pollution. A few shallow well waters from Newent which Mr. Duncan has analysed show a much smaller mineral content than the Spa water. In the Sixth Report of the Rivers Pollution Commission (1868), Report on the Domestic Water Supplies of Great Britain, 1874, p. 77 will be found twelve analyses of waters from shallow wells at Newent; the total solids vary from 232 to 42 parts per 100,000 and the chlorine from 28 to 1·78. These analyses show that the Spa Water comes from greater depth. There was an entire absence of sulphuretted hydrogen from the sample examined; but Murchison gives a section to illustrate his view with regard to a fault (downthrow to the west) and points out that the Coal Measures on the west contain much iron-pyrites which decomposing would afford "sulphuroneous springs."[1]

Robert Etheridge was of the same opinion as Murchison as to the origin of these sulphur waters.[2]

Newington Bagpath—Maps: 251; [35]; (57 N.W., S.W., N.E., S.E.)

Newington Bagpath village gets its water from springs (dip wells) thrown out by the Fullers' Earth. Springs near the School originate the stream which flows down Hay Bottom and the valley at Lasborough.

North-west of the cross-roads west of Calcot Farm is a well in Great Oolite, 60 ft. deep, tapping water at about 35 ft. from surface. The well was sunk in 1910 and the water is raised by a windpump.

Newland—Maps: 233; [35, 43 S.W.]; (38 N.W., N.E., S.W., S.E.)

The village of Newland is on the Old Red Sandstone. W. H. Davis, Surveyor and Sanitary Inspector, West Dean Rural District Council, has furnished me with the following information: —" 1.—Standpost near the Inn, cottages near Newland House, Newland House, South Lodge, and formerly Birchamp House, are supplied from a well between the railway and the Brake, 400 yds. north-east of All Saints Church. The present supply to Birchamp House is from a borehole in the stable near the road. 2.—Lecturage was formerly supplied from a well 90 ft. deep; but was abandoned because the quantity of water was unreliable. The new supply, which also supplies the Almshouses, is obtained from a well, 30 ft. deep situate 100 yds. to the east [of Lecturage]. 3.—The Vicarage Well is 30 ft. deep. 4.—Dark House Well is 40 ft. deep near the railway-tunnel; but the water fluctuates greatly. The original supply was situate in the south-western extremity of Bircham Wood, but was ruined by the railway-cutting. 5.—Tanhouse Farm has a good spring on premises." All the above supplies are from the Old Red Sandstone.

There are wells in the village of Clearwell, mostly shallow; but the majority of the people fetch their water from the copious Clearwell Spring, which is near the centre of the village.

Clearwell Court is supplied from a well, 30 ft. deep, in the Carboniferous Limestone.

Clearwell Spring (about 475 ft. above O.D.) is fed with water that has fallen on and worked through the Carboniferous Limestone, from which it is thrown out by the underlying Lower Limestone Shales. Near the spring-head is a fountain. On 15th Oct., 1922, the yield of the spring was about 110,000 gallons a day.

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[1] Murchison, R. I., *Silurian System*, 4to, London, 1839, pp. 155, 156. See also Dr. A. B. Granville, 'The Spas of England,' 1841, pp. 343, 344.

[2] Report on Various Schemes for increasing the Water Supply of the City of Gloucester, 13th July, 1891, p. 10.

Scatterford Farm is supplied with water from the Clearwell Stream, which is forced up by a ram to a reservoir near Roughpiece Wood, filtered, and gravitates back to the farm.

At the northern end of Bircham Wood, at the place indicated by the first "4" of the B.M. 495·4 on the 6-inch map, Sheet 38 N.E., a boring was made in 1903, in search of water, for the Coleford Urban District Council, but without success (below). A spring issuing near this borehole is collected into a small reservoir from which it gravitates to a standpost by the roadside to the north, which is used by the people of the Scowles in times of shortage. Water from another spring in the wood gravitates to Cherry Orchard and also supplies the little fountain on Newland Station premises.

St. Margaret's Well, Stowe, is a small spring, that has not been known to cease flowing. The water comes out of the Carboniferous Limestone. Most of the springs in this valley are small.

Noxon Pond is fed by a fairly constant spring.

Boring at Birchamp House, Newland.—Made in 1920 by, and particulars communicated by, Messrs. Guthrie Allsebrook and Co., Reading.

		Thickness Ft.	Depth Ft.
	Pit :—		
Old Red Sandstone	1. Rock	5	5
	Boring :—		
	2. Rock	28	33
	3. Red sandstone (very hard) ...	8	41
	4. Red marl	6	47
	5. Sandstone	1½	48½
	6. Rock in layers 18 in. to 24 in. thick with seams of marl ...	28½	77

Boring lined to about 21 ft. from surface with 6-inch internal diameter steel tube=16 ft. below bottom of pump-head pit. A little water was found at 26 ft. but ran away when the borehole reached 33 ft. Water struck at 48 ft. rose to 28 ft. below surface. Very hard sandstone was met with at 68 to 70 ft. and water rose 9 ins., *i.e.*, to 27 ft. 3 in. below surface.

A constant yield of 420 gallons per hour is pumped with but little depression in level (analysis, p. 268).

Boring in Bircham Wood.—Made in 1903 for the Coleford Urban District Council by Messrs. A. C. Potter & Co.

	Thickness Ft.
Soil	2
Lower Limestone Shales	41
Old Red Sandstone	257

North Cerney—Maps : 235 ; [34, 44] ; (43 N.W., N.E., S.W., S.E.)

The village of North Cerney, owned by Earl Bathurst, is supplied from a strong spring, thrown out by the Fullers' Earth, collected in a tank (8,000 to 10,000 gallons). From it the water is piped to three standposts and is laid on to some ten houses in the village. This supply is supplemented from another spring below the preceding.

The eight new Council Houses have water from a spring laid on to taps in the houses and the overflow is conveyed to a drinking pool and thence to the River Churn.

To North Cerney House water is forced from a spring—enfeebled in 1921—to a 2,000-gallon tank near the stables. The Rectory and six cottages are supplied by gravitation from a perennial spring in Cerney Park.

Scrubditch farmhouse, buildings and three cottages are supplied from a well (75 ft. deep) in the Great Oolite. The water is pumped to a 10,000 gallon tank.

Woodmancote.—See Rendcomb, p. 138.

Nordown, Cerney Downs, etc., are supplied from strong perennial springs thrown out by the Fullers' Earth at Perrott's Brook Mill. Water is raised to tanks (about 8,000 gallons): (1) on Cerney Downs, (2) at Long Plantation, (3) at Cross Roads, and (4) at Nordown.

The typical Cotteswold hamlet of Calmsden is supplied from the reservoir north-east of Greenmeadow Farm (Rendcomb parish). The spring feeding the troughs below the old Cross is thrown out by a clay bed in the Great Oolite Series. It is always running, but it is not used for drinking purposes. Opposite the Memorial Hall another spring breaks out.

Northleach—Maps: 235; [44]; (36 S.W.)

E. G. Hampshire, late Sanitary Inspector, Northleach Rural District Council, informs me that there are no wells in use in Northleach. Previous to 1896 water was obtained from the 'Bush Spring,' 'Knuckle Spring' (near the pond below the 'Wellings'), and others constituting what is known as the 'Old Supply.' This 'Old Supply' still supplies a few houses, but is gradually falling into disuse.

In 1896 the 'New Spring' supply was added by the Rural District Council. This spring is only some 20 to 30 ft. away from The Wellings or Seven Springs, and its waters are collected in a reservoir (10,000 gallons) in a chamber in the rock to which a door gives access. The following are gaugings of this 'New Spring':—

Aug.	1913.—12,240	gallons a day	(G. H. Phillott).
,,	1921.—11,520	,,	(E. G. Hampshire).
Sept.	1921.—11,512	,,	,,
Oct.	1921.— 7,200	,,	,,
Nov.	1921.— 6,600	,,	,,
Dec.	1921.— 5,960	,,	,,

Mr. Hampshire informs me (14th Dec., 1921):—"I have given you the exact figures of the monthly gaugings of the 'New Spring,' and you may safely take these figures as a guide to the diminution of all the Cotteswold springs due to the drought of this year [1921], as I find their variations are fairly constant with the flow of this spring in normal years.

"Cotteswold springs invariably break about the third week in November, but they have not done so this year [1921]. As we are some 12 in. under our normal rainfall this is not surprising."

From the reservoir the water is conveyed by a 4-inch main to Northleach. Into this main is conveyed water from the Bush Spring which is situate some 50 yds. to the east and yielded:—on 27th June, 1913, 2,743 gallons (G. H. Phillott), and on Oct., 1921, 700 gallons a day (E. G. Hampshire). The supply is distributed in the town by 3 and 4-inch mains: 108 houses in 1921 had a piped supply and there are 15 standposts.

The Vineries and Brewery House have private supplies from springs thrown out by the Fullers' Earth.

Messrs. Taylor and Co.'s Cotswold Brewery, which was purchased by the Cheltenham Original Brewery in 1919 and closed, obtained its supply from a spring in Prison Copse, ¼ mile north-north-west in Hampnett parish. The spring on the cricket ground north-east of the brewery is also connected with the brewery and in addition supplies Coalyard Farm in Eastington Parish.

The Seven Springs or Wellings.—These fine springs (in Eastington parish) yielded in June, 1893: 205,000 gallons a day (G. H. Phillott), and in Oct., 1921 (after an exceptionally dry summer and after the 'New Springs' had been taken for the main supply of Northleach)—50,000 gallons a day (E. G. Hampshire). They were acquired by Lord Sherborne in 1898 and water is taken by a 4-inch pipe to supply a ram about 100 yds. away. The ram pumps the water to reservoirs to supply the following farms, all of which are the property of Lord Sherborne:—Church Farmhouse and buildings, Northleach; Hill House farm and buildings near Farmington; Lower End Farm and buildings, Eastington; and Winterwell Barn, Eastington parish.

North Nibley—Maps: 251; [35]; (56 N.W., S.W., N.E., S.E.)

The public supply of North Nibley is a Village Pump. It is over a tank (brick and cement) that is fed by pipe with water collected on the west side of the road, but the 'spring' often dries up. On the whole the village is badly off for water. There are a few wells, however. The well (4 to 5 ft. diameter) at the White Hart is from 40 to 50 ft. deep. In February, 1927, the rest-level was 12 ft. down and has never been known to fail. Up Barr's Lane the well known as 'Barr's Lane Well' is about 40 ft. deep ('never fails'); that at Mr. Mason's about 40 ft. ('always some water but very little in dry weather'); and that in the northern corner of the field on the other (east) side of the road 45 ft. deep ('goes dry at times'). A boring was once made to a depth of 70 ft. in the garden of the house opposite the Ind. Chapel, but was abandoned as it failed to yield a supply.

At Hunt's Court Farm the well is 80 ft. deep, and in February, 1927, had 9 ft. of water in it. There is a good spring near Nibley Mill (on the Doverte Brook) and one that has 'never been known to go dry' on the west side of the road to the village at about 150 yds. to the south of the mill.

No springs that might be used for the purpose of a gravitation supply are thrown out by the Upper Lias in the side of the hill to the east of the village.

Norton—Maps: 216; [43 N.E., S.E. 44]; (18 S.E., 25 N.E.)

The majority of the 84 houses in the parish are dependent on wells: a few on a small spring by the roadside about a ½ mile to the south of the Red Lion Inn.

Notgrove—Maps: 217, 235; [44]; (28 S.W., S.E.)

Notgrove village is partly on the basement beds of the Great Oolite and partly on the Fullers' Earth, which throws out all the springs mentioned below.

The northern part of the village is served by a dip well, with lid, by the side of a trough and there are a few wells in the cottage gardens. The late C. Cunard had a scheme carried out whereby water from a spring, thrown out by the Fullers' Earth in Fishpond Coppice in the valley south of the Manor House, is pumped to a reservoir (30,000 gallons) on the high ground to the north-west of the village, from which it gravitates to the Manor House and houses on the estate.

Notgrove Station is supplied with water from a spring thrown out by the Fullers' Earth at Great Hill, on the Salperton Estate, to the west of the station. The overflow runs across the aqueduct to the barn on the south side of the line where it is used for watering the cattle.

Water, probably thrown out by the Snowshill Clay, in the field north of Notgrove Station, is collected and piped to a standpipe by the roadside immediately north of the Station.

Boring at Notgrove.—Said to have been near the Station. Made by Messrs. John Willis Titt and Co., Warminster.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Great Oolite	1. Rubbly limestone	6	0	6	0
	2. Hard limestone	5	0	11	0
	3. Marly limestone and marls ...	5	0	16	0
	4. Earthy limestone	1	2	17	2
	5. Marly limestones with marls ...	9	6	26	8
	6. Hard limestone	2	2	28	10
	7. Oolite	1	0	29	10
	8. Hard limestone	6	0	35	10
	9. Marls with two bands of limestone	8	0	43	10
	10. Oolitic shaly and marly beds ...	3	0	46	10
	11. Earthy oolitic limestone	1	0	47	10
	12. Earthy limestones	3	0	50	10
	13. Rubbly oolite	1	3	52	1
	14. Oolitic marl	2	0	54	1
	15. Rubbly oolite with bands of marl and shale	10	0	64	1
	16. False-bedded oolite with occasional marly layers	30	0	94	1
Fullers' Earth	17. Marl and shaly beds with two or three bands of sandstone ...	10	0	104	1
	18. Shales with thin gritty layers ...	9	0	113	1
	19. Shales	2	0	115	1
	20. Limestones	0	4	115	5

Notgrove.—On the upper [north] side of Notgrove Village in the field adjoining the main road.

Made in 1924 and particulars communicated by H. J. Godwin, Quenington, Fairford, Glos.

Surface-level.—About 780 ft. above O.D.

		Thickness Ft.	Depth Ft.
[Great Oolite]	1. Stone	20	20
	2. Blue clay	2	22
	3. Stone	58	80
[Fullers' Earth]	4. Clay and stone	33	113
[Inferior Oolite]	5. White stone	10	123
	6. Brown shale—water struck here ...	2	125
	7. White stone	46	171
	8. Brown shale—water struck here ...	2	173
	9. White stone	18	191

Rest-level.—170 ft. ex surface. Yield.—500 gallons per day.

The site was abandoned. Mr. Godwin wrote (24th March, 1924) :—"I was very disappointed that the yield was so small as the Diviner traced a really strong spring which is sufficient to drive a ram near Cold Aston and as he was quite ignorant of the ground I felt very confident of the results: faults, as you say, no doubt account for our failure."

Nympsfield—Maps: 234, 251; [35]; (49 S.W.)

Nympsfield village is dependent on wells and a "spout spring" towards the south-eastern end of the village. It is badly off for water. The springs thrown out by the Fullers' Earth in the parish are mostly small and used only for watering the cattle; but two between the village and Field Barn are constant.

Oddington—Maps: 217, 218; [44]; (22 S.W., S.E., 29 N.W., N.E.)

Oddington village has a public supply (Stow-on-the-Wold Rural District Council) from a spring thrown out by the Upper Lias clay well above the highest house in the village. The water is tapped at the spring-head. There are two reservoirs. The water is laid on to some 60 houses and to a number of standposts.

Oldbury-on-Severn—Maps: 250; [35]; (54 N.E., S.E., 55 N.W., S.W., 63 N.W.)

The parish is dependent on wells.

Old Sodbury—Maps: 251, 265; [35]; (69 N.W., S.W., N.E., S.E.)

The village is served by the West Gloucestershire Water Company.

Oldland—Maps: 264, 265; [35]; (72 S.E., 76 N.E.)

According to the L.G.B. Return, 1915 (p. 429), 338 houses out of 422 are supplied by the West Gloucestershire Water Company; those not so supplied are dependent on wells.

'California,' once a colliery, is now one of the sources of supply of the West Gloucestershire Water Company.

Olveston—Maps: 250; [35]; (62 S.E., 63 S.W., 67 N.E., 68 N.W.)

The village and Tockington, which are on the Carboniferous Limestone, are served by the West Gloucestershire Water Company, Parts are supplied by wells: there is a dipping well, fed by a good spring, at Tockington; a public well (15 ft. deep) fitted with a pump at Old Down; and two shallow wells (6 ft. deep; once dipping places) in Olveston village.

Owlpen—Maps: 251; [35]; (49 S.W., 57 N.W.)

The parish is supplied partly by wells and partly by a private undertaking. There was no shortage of water in 1921.

Owlpen House has water pumped to it from the Old Manor. Lampern House is supplied by gravitation from a spring thrown out by the Fullers' Earth by the side of the bend of the road to the east: near the B.M. 705·0.

Oxenhall—Maps: 216; [43 N.E.]; (17 N.W., S.W.)

W. Fox in his 'Report on the best means of increasing the Water Supply of the City of Gloucester,' 1st June, 1891, stated:—"Near Whitehouse (which is situated almost on the outcrop of the coal) a working for coal was commenced some years ago, and I have obtained from Mr. W. J. Clark, Mining Engineer, of Handsworth [Birmingham], who superintended the sinking of the shaft, a section of the top part, in which the greater part of the water was met with. This section gives particulars of the geological strata for a depth of 116 yards. I was informed locally that the total depth to the coal was 154 yards. Mr. Clark informs me that the greatest quantity of water to be contended with during the sinking was 60,000 gallons per hour, which was reduced to 42,000 gallons per hour after pumping had gone on for some time, below which it never went."

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[1] *Loc. cit.*, p. 9.

[2] Prof. C. Lapworth was informed by Clark that the pumping dried up some of the wells to the northward but left those to the south unaffected.

[3] In the Proceedings of the Cotteswold Naturalists' Field Club for 1892-93 (vol. xi, facing p. 16) is a "Section of Coal Field near Newent. Shaft B," which Robert Etheridge stated was given him by Fox. Doubtless it is the one which Fox stated in his Report had been given to him by W. J. Clark, and therefore of one of the shafts sunk by the Newent Colliery Company on the site of former workings below White House.

"The following analysis of the water was made by Dr. A. Bostock Hill, County Analyst of Birmingham.

In 100,000 parts.

Total solid matter		·48
Nitrogen as nitrates...		·55
Chlorine		1·3
Hardness :	Temporary	28·26
	Permanent	28·86
	Total	41·12

"This analysis was not made with a view to its fitness or otherwise for domestic supply, but on account of the effect which it had upon the boilers.

"The hardness is unusual for water from the sandstone formation and may possibly be due to some extraneous cause ; another analysis taken from the [Ell] brook close to the pit is very considerably softer."

Three farms in the parish have Gloucester Corporation water laid on : otherwise the parish is dependent on wells.

Gloucester Waterworks, Oxenhall.—Well sunk by Messrs. E. Timmins and Sons, Ltd., Runcorn. Commenced 8th Oct., 1894, and works completed and water delivered to City on 1st July, 1896.

		Thickness Ft.	Depth Ft.
	Well :—		
Triassic Sandstone	Surface soil and beds	11	11
	Sandstone with hard marls and conglomerates	47	58
	Hard conglomerate with large pebbles	30	88
	Sandstone and conglomerate ...	11	99
	Conglomerates	16	115
	Grey rock and conglomerate ...	7	122
	Hard red sandstone	6	128
	Conglomerate	17	145
	Hard red sandstone	23	168
	A boring about 100 yds. east of the well continues the section in :—		
	Conglomerates, marls and sandstones	132	300
	Sandstone of varying hardness ...	890	1190

The first 60 ft. of the well is lined with bricks and has an internal diameter of 12 ft. The next 90 ft. is lined with cast iron cylinders, and has an internal diameter of 11 ft. The cast iron cylinders are rings, each 5 ft. deep, made up of three segments bolted together. From the last ring but one, that is, at 145 ft. from the surface two headings (each 6 ft. 6in. by 4 ft. 6 in.) are driven, one in a westerly direction 145 ft. long, the other in a north-easterly direction, 117 ft. long. In driving the latter heading what was apparently a large fissure acting as an underground reservoir was unexpectedly encountered and the water came into the heading in such quantities that the men had to beat a hasty retreat and further driving was abandoned. These headings are not lined.

From the well the water is pumped to Madams Wood reservoirs, situate three miles from the Pumping Station and eight from Gloucester. The first reservoir (600,000 gallons) was constructed in 1894-95 ; the second (1,200,000 gallons), in 1901.

H. O. Jones has stated that in sinking the well "The dip of the strata was found to be about 1 in 60 from west to east, to a depth of 40 feet, where it began to increase until at 126 ft. in depth it was 1 in 12. The water overflowing from the bore-hole which was about 100 yards east of the well, was not affected until a depth of 26 ft. was reached ; and the water-level in the colliery shaft, 1 mile north-west of the well, which was 46 ft. from the surface

at the commencement of the well-sinking, was not altered until a bed of conglomerate, which extended from 58 ft. to 88 ft. in depth was passed. . . ."[1]

Previous to the sinking of the well, but also in 1894, a trial boring was made for the Gloucester Corporation by the Diamond Boring Co. of Belvedere Road, about 100 yds. east of the well.

The boring, the top of which is 102·5 ft. above O.D. was taken down to a depth of 290 ft. for the Corporation, through beds of conglomerate, marls and sandstones. At a depth of 66 ft., after passing through a bed of conglomerate, water was reached under a pressure which caused it to overflow on the surface, while at a depth of from 140 to 176 ft. below the bed of conglomerate it rose nearly 4 ft. above the surface of the ground. The borehole was lined with steel tubes from 12 in. to 9 in. diameter down to a depth of 290 ft.[2]

The Onslow Trustees, who were owners of the land on which the boring was made, made arrangements with the Diamond Boring Co. for continuing this boring in the hope of finding coal. This was done with a 7-inch crown to a depth of 1,190 ft. from the surface, but without getting through the Triassic sandstones. The last bed of conglomerate was passed at 357½ ft. down and below only red sandstone of a very uniform character (? Bunter) was encountered.

The water met with in the borehole contained a greater and greater quantity of sodium chloride as the depth increased. G. Embrey[3] sets out the results of his examinations as follows :—

Depth in feet	Grains per gallon	
	Solids	Common salt
300	160	12·52
350	166	13·17
400	162	13·17
450	152	11·85
500	158	12·84
550	184	14·49
600	160	13·17
650	152	13·5
700	152	19·1
750	140	22·73
800	206	50·84

The solids, he states, were almost entirely composed of gypsum and common salt.

In consequence of the increasing salinity of the water, the borehole was filled to up within 453 ft. of the surface.

Oxenton—Maps : 216, 217 ; [44] ; (12 S.E., 19 N.E.)

The village is supplied by an undertaking that was installed by the late Lord Ellenborough. The source of supply is a spring issuing from the Sandy Beds of the Middle Lias in the hillside above Hill Farm. The water is piped to covered reservoirs in the field near the farm whence it gravitates to standposts in the village.

Ozleworth—Maps : 251 ; [35] ; (56 S.E., 57 S.W., 64 N.E., 65 N.W.)

Ozleworth village, partly on Fullers' Earth and partly on Inferior Oolite, is dependent on springs (dip wells). Springs are thrown out by the Fullers' Earth, and copious springs—amongst them a local " Seven Springs "—issue from the base of the Cotteswold Sands.

[1] *Proc. Inst. F. E.*, vol. cxlviii, pt. 2, 1905, pp. 341-342.

[2] The bottom piece of the 7 in. core is in the Gloucester Museum.

[3] *Proc. Cotteswold Nat. F. C.*, vol. xx, pt. 1 for 1918 (1919), p. 42.

Painswick—Maps: 234; [34, 44]; (33 S.E., 34 S.W., 41 N.E., S.E., 42 N.W.)

Painswick is supplied by the Stroud Water Company, many wells, and public springs, such as that at the bottom of Vicarage Street (under the Vernon's boundary wall) and St. Tabitha's Well in Tibbiwell Lane. A good supply is running to waste, except for what is used by people living around, near Gas House.

The spring at Cherry Hill Cottages, Spoonbed Hill, which is thrown out by the Upper Lias clay, was at one time considered as a possible source of supply to Painswick, but it was found that the drainage from the cottages, etc., had been into the fissures in the rocks and it was feared that the water would be polluted.

Sheepscombe is supplied by wells and springs. The wells vary in depth from about 30 ft. on the north side of the valley to over 100 ft. on the south side.

Slad hamlet has a piped supply (Rural District Council) from a spring thrown out by the Upper Lias clay near Laurel Villa. The water is pumped up by a ram to a reservoir but a good overflow runs into Steanbridge pond. Cud Well is a spring (somewhat feeble) thrown out by the clay. At 300 yds. N. by W. of Steanbridge is a spring that is piped to supply Steanbridge House, and at 150 yds. to the N. by W. several springs (marked on the 6-inch map, 41 S.E.) the southernmost of which, it is said, 'never fails.' There is a useful spring at the back of the Star Inn.

Pauntley—Maps: 216; [43 N.E.]; (17 N.W., N.E., S.E.)

Pauntley village is on Keuper Sandstone and is adequately supplied with water from wells. Poolhill hamlet is also supplied with water from wells, some of which are very deep. The following are particulars of one of them :—

Surface level.—About 215 ft. above O.D. Depth to water.—100 ft. Depth of water.—50 ft. Total depth.—150 ft.

Durbridge Farm has a well 80 ft. deep.

At Little Nutham between Botloe's Green and Ketford Bridge, the well is 160 ft. deep and on July 12th, 1922, had only 3 in. of water in it. This unusual occurrence was attributed to pumping at the Gloucester Corporation's Waterworks at Ketford.

Pauntley Spa.[1]—Between Payford and Dur Bridges a number of mineral springs discharge their waters into the River Leadon. One of these (No. 6 on the sketch-map[1]) is designated 'Pauntley Spa (disused)' on the 6 inch map, Sheet 17 N.E. (ed. 2, 1903). It was the custom of the Newent people and others to go to this Spa on the evening of the 30th April in order to be ready to drink the waters early on May Day.[2]

Sulphuretted hydrogen can be distinctly smelt in the neighbourhood of 'Pauntley Spa' (6) and the shallow well (2). The sample from (2) sent by the Rev. R. Lingard Simkin to Mr. Duncan on 26th July, 1922, had no odour when received;[3] but that taken on 17th March, 1923, had a distinct odour of the gas but the quantity present was small. Mr. Duncan is of opinion that the sulphuretted hydrogen gas detected from time to time in the neighbourhood is derived from fermenting vegetable matter in the presence of much sulphate and not from a mineral source.

[1] For a full account of this Spa see Duncan, C., and L. Richardson, *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), pp. 157-159.

[2] A. R. Winnington Ingram, *Proc. Cotteswold Nat. F. C.*, vol. xi, pt. 1 for 1892-93 (1893), p. 35.

[3] Mr. Duncan tells me that it is a well-known fact that the smell of sulphuretted hydrogen fairly rapidly disappears when a sample is kept in a bottle which warms up. He frequently has samples coming from the Lower Lias clay, which, when taken, smelt of sulphuretted hydrogen gas, but when the samples reach the laboratory, in the majority of cases has disappeared.

The water from the spring (5) is not mineralized : it is good water and the yield of the spring does not vary with the seasons.

Ketford Pumping Station, Gloucester Corporation Waterworks.—No. 1 Borehole,[1] made by Messrs. E. Timmins and Sons, Ltd., Runcorn. At the Pumping Station : commenced 7th Oct., 1910 ; finished 12th June, 1911. Ht. above O.D., 89·64 ft. Diameter inside casing, 15 in. to 353 ft ; 12 in. to 359 ft. Sunk in Trias.

	Thickness Ft.	Depth Ft.
Reddish sandstone beds with pebbly layers ...	31	31
Sandstones with pebbles	1	32
Conglomerate	1	33
Sandstone bed (in some places finer grained than in others) with pebbly layers at various horizons	53	86
Sandstone bed with more numerous and larger pebbles than above	55	141
Sandstone without pebbles	1½	142½
Hard sandstone with more and larger pebbles than usual	5	147½
Sandstone beds	36½	184
Sandstone bed overlying conglomerate ...	30	214
Sandstone beds	21	235
Sandstone with thin bed of marl and a little conglomerate	4	239
Sandstone and conglomerate	64	303
Sandstones with varying quantity of pebbles ...	50	353
Conglomerate, pebbles larger than those in the higher beds, clay nodules present	6	359

Rest-level.—7 ft. ex surface.

No. 2 Borehole.[2] 70 yds. south-eastward from the Pumping Station : commenced 7th December, 1914 ; finished 9th February, 1915. Ht. above O.D. 89·98 ft. Diameter, 18 in. to 149 ft. ; 15 in. to 447 ft. 6 in.

Triassic sandstones and conglomerates ... ... 447½ ft.

Rest-level.—5½ ft. ex surface.

The cores from No. 1 Borehole down to a depth of 353 ft. had a diameter of 18 in. ; but from 353 to 359 ft. they were smaller, as a 14¼-inch crown was used for drilling. Portions of the core were ground to sand ; but the specimens of the hard portions which were selected for preservation in the Gloucester Museum are typical examples of the beds from which they were derived.

Pebworth—Maps : 200 ; [54 S.E.] ; (3 N.W., N.E., S.W., S.E.)

The water-supply of the village is obtained from the Evesham and Pebworth Joint Water Committee. Previous to the introduction of this source of supply the village was dependent upon shallow wells, and, as in the case of the majority of wells in villages on the Lower Lias clay of the Vale, in dry seasons some yielded no water, and in nearly all cases were so contaminated that the waters were unfit for drinking purposes.

Dr. D. Gordon Evans, M.O.H., for the Pebworth Rural District, informs me that there are only a few scattered houses in the Vale, which are situate too far from public water-supplies which are now dependent on wells, but that the water in the surface-wells, being fed only with that which has percolated through the subsoil, is in all cases more or less contaminated with organic matter, so that the wells are gradually being done away with in favour of supply from public sources.

[1] Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 3, 1912, p. 351.

[2] Information supplied by C. J. Scudamore, City Surveyor and Waterworks Engineer, 11th Feb., 1929.

Mr. Manuell of Pebworth obtained the following particulars concerning certain wells:—Broad Marston. 1.—Orchard Dene. Not very deep. Water obtained by bucket, no windlass. Depth from surface to water, 3 to 4 ft. Supply constant. Not fit to drink. 2.—'Shoulder of Mutton' Inn. Not very deep: water obtained by pump. Supply constant. Not fit to drink. Pebworth. 1.—Fine well near coppice near village. Rather deep. Depth from surface to water, 3 to 4 ft. Supply constant. Fit to drink. 2.—Friday Street (Mr. Kilby's). About 12 ft. deep. Water never reaches the top. Fails in dry summer. Not fit to drink. 3.—Top of village. Two wells in front of cottages. Depth 12 ft. Supply constant. Water from these wells is used for drinking when tap water is cut off.

Pinnock-and-Hyde—Maps: 217; [44]; (20 N.E., S.E., 21 N.W., S.W.)

The section of the road from Farmcote to Lyne's Barn near the latter place is a portion of the divide between the Severn and Thames Systems. At Lyne's Barn is the source of supply to Hailes, Toddington Manor, Grange and Vicarage, several farms and a portion of the village, also Toddington Station. The source of supply is a well (30 ft. deep) in the field on the north side of the road, but close to it and to Lyne's Barn. The well is in the Cotteswold Sands (see also Hailes, p. 98).

The water feeding the strong spring at Slade Barn or Bradwell's Head Barn has an obviously good catchment-area in the fine valleys above the place of outburst. The water issues from the Cotteswold Sands, is caught in the two reservoirs, and is piped direct in 1-inch galvanized iron pipes to Hyde Farm (cottages, cattle troughs, etc.).

At Broadwater there are very strong springs which come out in two places, 1—up a little comb running north-eastwards; 2—a little to the west. The water issues from the Cotteswold Sands. Close by (1) is the ram that forces the water over the hill to New Barn Farm, Temple Guiting.

Pitchcombe—Maps: 234; [44]; (41 N.E., S.E.)

J. C. Carruthers-Little, of Pitchcombe House, informs me that nearly every house has a different source of supply: some from springs, some from wells, and some have Stroud Water Company's water laid on.

Poole Keynes—Maps: 252; [34]; (59 N.W., S.W.)

At Poole Keynes there are few wells (about 15 ft. in depth) in use, for water has been laid on by Lord Biddulph from Oakwell to three taps.

Oakwell springs rise from under and in the vicinity of Oakwell Cottages, near the county-boundary south-west of Westend Farm, Poole Keynes. Some are seen 'boiling up' in the gardens of the cottages: seven or eight smaller ones rise in the brook close to on the west and yet others in a field to the south. They have always been very constant with the exception of the period Sept., 1921, to Jan., 1922, when they ceased to flow. There is a swallow hole in the ground known as 'The Riding' (p. 27).

Poulton—Maps: 235; 252; [34]; (52 N.W., S.W.)

The village of Poulton is supplied by wells, 'Poulton Spring,' and a supply, which is laid on to the houses, from near Ready Token, but in Meysey Hampton parish. The wells in the Cornbrash are shallow: one in the field south of 'Ye Old Falcon' Inn is 9 ft. deep with 2 ft. of water in it. 'Poulton Spring' is fed with water thrown out of the Cornbrash and is walled up to form a circular dipping place. It supplies a good many houses and has not been known to fail.

Four cottages at Ready Token depend on a deep well, said to be a Roman Well, and rainwater collected off the roofs of all four and stored in an underground tank fitted with a pump. The well is a draw well, 145 ft. deep, and on 22nd Aug., 1922, had 21 ft. of water in it.

Well at Hartwell Farm.—The private supply referred to above as "near Ready Token, but in Meysey Hampton parish."

Source of supply.—Deep well and borehole, together 192 ft. deep. Strata penetrated.—Forest Marble and Great Oolite to Fullers' Earth. Works.—Reservoir (30,000 gallons) behind Hartwell Farm House. Sufficiency.—The daily average quantity of water supplied is 1,756 gallons. The supply is constant and unlimited. Places supplied.—Hartwell Farm, Sunhill, Poulton Priory, Poulton Firs and a number of houses (including the Vicarage) in Poulton village.

Prescott—Maps: 217; [44]; (20 N.W., S.W.)

'Prescott Spring' feeds a reservoir near Prescott House, which supplies the House, Mr. Newman's house and farm, cottages, etc. Dr. T. Wright and D. J. Humphris reported of the spring that they found the yield to be (14th October, 1863) 10,080 gallons a day.[1]

About ¼ mile south by east of the lower of the two Manor Farms marked on the six-inch map is a spring which Chas. Gardner found to yield 8,640 gallons per 24 hours. Presumably the spring issues from the Sandy Beds of the Middle Lias.

Prestbury[2]—Maps; 216, 217; [44]; (19 S.E., 26 N.E., 27 N.W.)

Prestbury village is mainly on a superficial sand-bed and is mostly supplied with Cheltenham Corporation water, but houses not so supplied in village and parish are dependent on wells, the quantity and quality of the water in which are said to be variable.

The springs above Knowle Hill Farm and near Lower Hill Farm yielded, according to G. H. Phillott, on 19th Oct., 1911, 53,222 and 14,400 gallons per day respectively. They have been considered as a source of supply for Cleeve Hill hamlet, and in 1863 as an additional source for Cheltenham.[3]

At Piccadilly there are two small springs concerning which Dr. Wright reported that they "yield all the year round as much water as will fill an inch pipe; this water flows into the ditches and finds its way to the south of Prestbury.

"Holly Tree Spring forms a small reservoir. The water, it is said, always stands at the same level, and is not dry in summer, the excess being lost in the rock."[4]

J. W. Gray, of Cheltenham, informs me that "a chalybeate spring issues from a bank a short distance (about 200 yds.) to the east of Noverton Mill. The water, which does not appear to be strongly impregnated with iron, had a local reputation as a remedy for affections of the eyes." The water would appear to come from at or near the base of the Middle Lias.

The Hyde Spa.—In his 'Dissertation'[5] Dr. D. W. Linden demonstrates that "the waters of this salutary spring are in every respect superior to Cheltenham Water." He gives an analysis of the water and recommends its use in certain diseases.

The Hyde Estate is on the west side of the Evesham Road about two miles from Cheltenham, close to the western boundary of the parish of Prestbury. Careful inspection has not, however, succeeded in locating any such spring.

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[1] 'Report on the sources of an Additional Supply of Water to the Town of Cheltenham,' Cheltenham, 1863, p. 14.

[2] Richardson, L., *Proc. Cotteswold Nat. F.C.*, vol. xvii, 1912, pt. 1, pp. 297-310. (Contains six-inch map, Sheet 26 N.E. geologically coloured.)

[3] Wright, Dr. T., and D. J. Humphris, 'Report on the Sources of an Additional Supply of Water to the Town of Cheltenham,' Cheltenham, 1863, p. 11.

[4] Report, p. 12.

[5] Linden, Dr. D. W., 'An Experimental Dissertation on the Nature, Contents, and Virtues of the Hyde Saline Purging Water, commonly called The Hyde Spaw, near Cheltenham, in Gloucestershire. London. 1751. 8vo.

Not far away from where the Hyde Spa must have been situated, a highly saline medicinal water was encountered on the Marle Hill Court Estate in a well sunk in the Lower Lias clay in 1904. The well is now on property belonging to C. Reeves and is situate on the left hand side of the road leading from Rosehill to Swindon (analysis, p. 270). An account of the Hyde Spa and this well by the writer appeared in 1927.[1]

Preston (near Cirencester)—Maps: 235, 252; [34]; (51 N.E., S.E.)

This parish is on Forest Marble and Cornbrash. The village of Preston (Abbey Estate) is supplied from a six-inch borehole, 108 ft. deep, through Cornbrash, Forest Marble and ? into the top beds of the Great Oolite. The water is raised by a windpump to an underground reservoir (10,000 gallons).

Preston (near Dymock)—Maps: 215, 216; [43 N.E.]; (9 N.E.)

There is no village, the houses being scattered sparsely throughout the parish, which is on Old Red Sandstone. Some of the older cottages have a well to each one, but generally the newer cottages have a well to each pair.

Preston-on-Stour—Maps: 200; [54 S.E.]; (2 S.E., 4 N.W., N.E.)

The village is supplied by wells and I am indebted to G. F. Clark for the particulars given below. These wells are in the Keuper Marl and yield a constant supply of good water.

	Total depth of well	Depth ex surface to rest-level of water
	Ft.	Ft.
The Rough Farm	90	60
Whitehill Farm	80	68
Sylvester's Cottages...	60	50
Cottages 3 to 10 (Preston-on-Stour) ...	50	40
,, 11 to 18	40	30
The School	40	32

Alscot Park is supplied from a well.

Prinknash Park—Maps: 234; [44]; (33 S.E., 34 S.W.)

H. Knowles informs me :—" For a long time past most of the small houses have been supplied from a spring on Overtown Farm by gravitation. Prinknash Park is likewise supplied from a spring by gravitation." (See also Upton St. Leonards.)

Pucklechurch—Maps: 265; [35]; (72 N.E., S.E., 73 N.W., S.W.)

In Pucklechurch village, which is on the Lower Lias, some 44 houses (out of 298 in the parish) situate about 500 yds. from Parkfield Colliery (Bedminster, etc., Collieries Ltd.), and approximately a mile from the village, are supplied from a spring issuing, David Sharp, the manager, informs me, from the Keuper Marl at about 60 ft. down the shaft. The average daily quantity of water supplied is 40,000 gallons. Otherwise village and parish are dependent on wells (analysis, p. 270), insignificant springs and rain-water.

Brandy Bottom Pit, near Pucklechurch, is described by H. B. Woodward.[2]

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[1] *Proc. Cotteswold Nat. F.C.*, vol. xxii, pt. 3 for 1926 (1927), pp. 263, 264.

[2] 'Geology of East Somerset and the Bristol Coal-Fields' (*Mem. Geol. Surv.*), 1876, p. 37.

Quedgeley—Maps: 234; [43 S.E.]; (33 N.W., S.W.)

Quedgeley parish is on the Lower Lias. Out of the 190 houses 25 are supplied with Gloucester Corporation water, the remainder by wells.

Quenington—Maps: 235; [34]; (52 N.E.)

The village of Quenington is supplied partly from the River Coln at Coln St. Aldwyn and partly from the Hatherop undertaking. The two schemes are so arranged that they can be linked together in the village if necessary.

The water from the Coln is passed through a gravel filter and raised to a tank (500 gallons) near Conegar Farm, from which it gravitates to an underground reservoir (20,000 gallons) near Quenington Village Green. Conegar Farm, buildings and cottages are supplied from this undertaking and in the village of Quenington water is laid on to the Court, etc., and to some standposts.

The water from Hatherop is received in a reservoir (10,000 gallons) at Quenington Farm. A number of houses have the water laid on and the water supplies four standposts.

The windpump near H. J. Godwin's Works raises water to a 600-gallon tank, for the supply of two houses, from a well 116 ft. deep.

The well at Donkeywell Buildings supplies two cottages. It is 150 ft. deep, through the lowermost beds of the Forest Marble, Great Oolite to ? Fullers' Earth. In August, 1922, it had 40 ft. of water in it, but it runs dry at times.

Boring at Honeycombe Leaze.—Made and communicated by H. J. Godwin, Quenington. May and June, 1925. Ht. above O.D., 350 ft.

		Thickness Ft.	Depth Ft.
[Great Oolite]	Brown stone	17	17
	Blue stone	8	25
	White stone	6	31
	Blue stone	10	41
	Brown stone	4	45
	Blue stone	7	52
	White stone	2	54
	Blue stone	8	62
	White stone, containing soft bed of shale	11	73
	Blue stone	18	91
	Blue clay	4	95
	Blue stone	5	100
[Fullers' Earth]	Clay with beds of stone ...	38	138
[Inf. Oolite]	Blue stone	7	145

Rest-level.—39 ft. down. Yield.—700 gallons per hour.

The classification is only approximate.

Quinton—Maps: 200; [54 S.E.]; (4 N.W., S.W., 8 N.W.)

Upper Quinton is supplied by an undertaking belonging to the Chipping Campden Rural District Council; Lower Quinton by an undertaking belonging to Magdalen College, Oxford. The sources of both supplies are springs issuing from the Sandy Beds of the Middle Lias at Meon Farm, and the capacities of the reservoirs are—that belonging to the Council, 2,000 gallons; to the College, 9,000 gallons. The water of the College undertaking is filtered before it is stored. Out of 98 houses in the parish 81 obtain their water from the above undertakings: those not so supplied are dependent on wells.

Randwick—Maps: 234; [35, 43 S.E.]; (41 S.W., S.E.)

The village owes its supply to the generosity of the late Mr. Carpenter, and derives it from a spring at Long Court.[1]

Rangeworthy—Maps: 251; [35]; (63 S.E., 64 S.W., 68 N.E., 69 N.W.)

The eastern two-thirds of the parish, on the Coal Measures, F. W. Davies, the Sanitary Inspector, informs me, is well supplied with water at about 15 ft. down: the western third on the Keuper Marl gets good supplies at about 10 ft. down.

Rangeworthy New Pit is described by H. B. Woodward.[2]

Redwick-and-Northwick—Maps: 250; [35]; (62 N.W., N.E., S.W., S.E., 67 N.W., N.E.)

Redwick and Northwick are served by the West Gloucestershire Water Company. The water in the wells in the parish, which is on Severn-side alluvium, is not satisfactory for drinking purposes.

Rendcomb—Maps: 235; [44]; (35 S.W., S.E., 43 N.W., N.E.)

The upper part of the village of Rendcomb and the mansion (now a school) are supplied from two springs, thrown out by the Fullers' Earth, a little under 1 mile west by north of Rendcombe Church. The water gravitates to underground tanks (5,000 gallons) at the rear of Rendcomb House. The overflow from these feeds a 2,000-gallon tank in the tower of the stables (for the supply of the stables and cottages near), and the overflow from this an underground tank in the village, which has a pump over it serving most of the cottages around.

The Mill and lower part of the village are supplied from two springs, thrown out by the Fullers' Earth, in Hackpenny Wood, a little over ½ mile west of Rendcomb Church. The spring-water is collected into a tank (1,500 gallons) from which it gravitates to taps.

Rendcomb Park Estate.—This estate, which was sold by the direction of F. Hubert Taylor in 1914, is supplied for the most part—other than the mansion and village of Rendcomb—from the pumping station at Marsden where a pump (capacity 500 gallons per hour) worked by a water-wheel raises water from a strong spring issuing from the Cotteswold Sands to a reserve reservoir (35,000 gallons) situate to the north-east of Iffcomb Wood. Thence the water supplies Shawswell Farm (where a small spring also contributes to the supply) and is piped to a pumping station at the southern end of the pond below Greenmeadow Farm. From here (along with water from a spring close by) it is raised to Greenmeadow reservoir (95,000 gallons). Rams in the valley some 650 yards to the W.N.W. also force up water to this reservoir from which Greenmeadow Farm and Field Barn, Rendcomb Buildings, Cirencester Barn, Calmsden hamlet, Folly Barn, Old Gore Barn, Mount Pleasant and Ballinger's Farm and fields are supplied.

From the Marsden pumping station a main leads to a reservoir between Woodmancote (North Cerney parish) and Rapsgate, whence the water supplies Woodmancote Farm and village, also Cotswold Park and neighbouring properties.

Rendcomb Springs are marked on the geological map, but were dry when I visited the locality in August, 1922.

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[1] The spring is marked on the six-inch map 41 S.W. It is that about 100 yds. W.N.W. of the fish-pond in the grounds.

[2] 'Geology of East Somerset and the Bristol Coal-Fields' (*Mem. Geol. Surv.*), 1876, p. 38.

Rockhampton—Maps: 250, 251; [35]; (55 S.E.)

The parish is dependent on wells. One at the School supplies several houses, but F. W. Davies, the Sanitary Inspector, informs me that the parish is "not a good one for water."

Rodborough—Maps: 234; [34]; (49 N.E.)

Rodborough (including King's Court) is served by the Stroud Water Company, but there are some wells in use and many in other parts of the parish tapping water in the Cotteswold Sands. These vary in depth from 20 to 175 ft. (Bownham Cottage) according to situation—the deepest being on the higher ground. Numerous springs issue from at or near the base of the Sands in the hill-side. The most notable are:—Stanfields Spring, which, J. Hall informs me, ran well, to his recollection, for 25 years but went dry in 1921; King's Court (marked on the six-inch map 49 N.E.), which is a good spring and available for public use; Court Bank, in the Stroud Valley, some 500 yds. north-east by north of Rodborough Fort; and about 500 yds. east by north of Rodborough Manor.

There are 'lissons' or 'lissens' in the Inferior Oolite of Rodborough Hill similar to those at Nailsworth (p. 194).[1]

Rodmarton—Maps: 251, 252; [34]; (50 S.E., 58 N.W., N.E., S.E.)

Rodmarton, Tarlton, Culkerton and Jackaments Bottom Farm are supplied by an undertaking belonging to the Hon. Claude Biddulph. The following are particulars of it:—

Source of Supply.—Well, 50 ft. deep, with two headings in Great Oolite at Mountpleasant—½ mile west by north of Jackaments Bottom.

Works.—Pumped to water-tower (6,000 gallons) at Tarlton, from which the water gravitates to the localities mentioned, where it is laid on to the principal houses and to ten standpoints in various places.

E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, informs me that the rest-level of the water appears to keep about the same as that in the well at the Pumping Station of the Great Western Railway at Kemble Station and in that of the disused Pumping Station (Thames and Severn Canal) at Thames Head. Usually there is about 3 ft. 6 in. of water in the Mountpleasant Well in summer and 5 ft. in winter, and during the drought of 1921, on an average, 3 ft. 3 in.

H. B. Woodward states that "A well-boring at Tarlton . . . was carried to a depth of 100 ft. (in 1893) without finding water."[2]

Mr. Mathews also informs me that the two Council Cottages at Culkerton are supplied from a well in Forest Marble, 14 ft. deep, 11 ft. in diameter, which had in it on 22nd June, 1922, 9 ft. of water, and during the drought of 1921, about 5 ft.

Four Mile Cottages, Tetbury Road, are supplied by a well 51 ft. deep in Great Oolite. This was dry in summer of 1921, but had 11 ft. of water in it in April, 1922.

Roel—Maps: 217; [44]; (20 S.E., 21 S.W., 27 N.E., 28 N.W.)

Water is pumped up by a ram from the spring near Spoonley Cottage to Roel Hill.

Ruardean—Maps: 233; [43 S.E.]; (23 S.W., S.E., 31 N.W., N.E.)

The majority of the people in the village obtain their water from 'Caudle Well,' a surface well fed by water which is piped to a short distance

[1] Richardson, L., *Geol. Mag.*, vol. lviii, 1921, p. 130.
[2] 'The Jurassic Rocks of Britain' vol. iv (*Mem. Geol. Surv.*), 1894, p. 509.

from a spring. The well is constantly overflowing, but during the drought of 1921 the yield of the spring was halved and the majority of the wells went dry.

Rudford—Maps: 216, 234; [43 S.E.]; (24 N.E., S.E.)

This parish, on the Keuper Marl, is dependent on wells.

St. Briavel's—Maps: 233; [35]; (38 S.W., S.E., 39 S.W., 46 N.W., N.E., 47 N.W.)

Water for the supply of the village is obtained from two wells near the Old Crown Inn, which catch springs issuing from the topmost beds of the Old Red Sandstone. The service has four taps (including the 'Jubilee, 1887' tap in the Castle-grounds boundary-wall) and the overflow gravitates to the Castle. There are a few wells and 'reservoirs' (rain-water tanks) in the village.

Bearse Farm, at the head of Slade Bottom, obtains its water from a well in Carboniferous Limestone some 220 yds. to the east, but as the supply has failed of late steps are being taken to instal a ram at the spring in Slade Wood.

The well at Longley Farm is 116 ft. deep, through Carboniferous Limestone, and in October, 1922, had 16 ft. of water in it.

'The Linders,' Mork, has a piped supply from the spring near the Slade Brook to the north of Morkhill House.

Saintbury—Maps: 200, 217; [44]; (7 N.W., N.E., S.W., S.E.)

The village is supplied with water by a private undertaking belonging to G. B. Blackwell. The source of supply is a spring issuing from the base of the Cotteswold Sands situate some 250 yds. E.S.E. of Gun's Cottages on Saintbury Hill. There is no filtration and no reservoir and the water is carried by pipes to all the houses except two at Saintbury grounds. The water is good and the supply is adequate.

"The drainage of this village is of a primitive nature, and being on a porous subsoil, very little of the sewage finds its way into the ditches, as it percolates into the deeper strata and becomes lost."[1]

Salperton—Maps; 217, 235; [44]; (27 S.E., 28 S.W.)

Salperton Park and village are supplied by a private undertaking (provided by G. L. Foster Harter) from the Hay Springs, thrown out by the Fullers' Earth on the west side of the valley north of the village and railway. These springs (one strong and constant; the other feeble and unreliable) are piped into a catch-pit from which there are two pipes, one to supply the rams, the other the village reservoir. The rams pump the water to three tanks (500 gallons each) at the top of Salperton Park house and to two (500 gallons each) for the supply of the buildings and gardens. From the reservoir the water gravitates to standposts in the village.

A spring thrown out by the Fullers' Earth is run into a tank for the supply of the Home Farm and the overflow discharges through a pipe in the village. Another spring at Great Hill, on the Salperton Estate, supplies Notgrove Station and a barn (p. 127).

Sandhurst—Maps: 216; [43 N.E., S.E., 44]; (18 S.W., S.E., 25 N.E., N.E.)

The greater part of the village is on a superficial sand-bed.

The 96 houses in the parish are dependent on wells. Those near the Church are 10 to 20 ft. deep and are said to rise and fall with the Severn.

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[1] Dr. D. Gordon Evans, 'Ann. Rep. for the year 1906 on the Pebworth Rural District. . . .' Evesham, 1907.

Boring at Wallsworth Hall[1].—At the time the boring was made there were three wells at the Hall, respectively 20, 22 and 24 ft. deep, but the water from the first near the south-eastern angle of the house was so hard that it could not be used for domestic purposes. The yield from the other two wells was inadequate.

Particulars of Boring.—Surface-level, about 50 ft. above O.D. Date of sinking, 1911-12 (percussion bored).

	Thickness Ft.
Well (40 ft. deep, 9 ft. diameter) :—	
Lower Lias clays and limestones	40
Boring (130 ft. deep, 4 in. diameter) :—	
Lower Lias clays and limestones	130

Progress with the boring was slow on account of the very tough nature of the Lower Lias clays and limestones. The borehole at the finish was still in the Lower Lias. Sufficient water was obtained and ample storage room (in the well) was provided as it was surmised that water would come in slowly. (Analysis, p. 271.)

Sapperton—Maps : 234, 235, 251, 252 ; [34] ; (50 N.W., N.E., S.W., S.E.)

Water from a moderately strong spring thrown out by the Fullers' Earth is forced up by ram to a 300-gallon tank on the village green, where there is a public tap, and is laid on to the Manor Farm (tank : 1,000 gallons), Rectory, and Glebe Farm. Otherwise the village is dependent on wells from 10 to 60 ft. deep : the deeper ones continued to yield an adequate supply during the drought of 1921, but the shallower ones gave out.

Water from a strong perennial spring is forced to an underground tank (5,000 gallons) for the supply of Pinbury Park House and to a storage tank (about 300 gallons) for the supply of Park Corner Farm and four cottages in Duntisbourne Rouse parish and Overley Farm in Daglingworth parish.

Frampton Mansell hamlet is supplied from a strong perennial spring thrown out by the Fullers' Earth, water from which is conveyed to several stone troughs, the one overflowing into the other at lower levels. From these some 28 houses obtain their supplies.

A well at Hailey Farm is 130 ft. deep, 6 ft. in diameter, in solid Great Oolite rock. In June, 1922, it had 10 ft. of water in it.

Cassey Well spring issues from Forest Marble beds. Although weak it never fails, and its waters are collected into an underground tank from which they are piped to supply two cottages on Hailey Farm, three at Tumbledown, and the G.W.R. Signal Box.

Sevenhampton—Maps : 217 ; [44] ; (27 N.W., N.E., S.E.)

The village is down in the valley of the Coln, in a markedly narrow and deeply excavated portion of which trickles the young river over a surface of Upper Lias clay. Cotteswold Sands succeed the clay which throws out the spring near the School, east of the Church, from which the supply to the village is obtained. The water is forced up by a ram to a tank in a building near the Manor House, from which it supplies that house and gravitates to the houses of the village.

The upper part of Brockhampton hamlet is supplied by a spring, thrown out by the Fullers' Earth, on the hill to the south-east. The water is piped to a reservoir whence it gravitates to standposts. This supply gave out in 1921, and the villagers had to obtain water from the perennial "Donny Well." The lower part of the hamlet is supplied from Donny Well Spring below the Brewery.

[1] Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xviii, 1914, pt. 3, pp. 247-249.

A fine spring is thrown out by the Upper Lias clay below Puckham Farm.

Sezincote—Maps: 217; [44]; (14 S.E., 15 S.W., 21 N.E., 22 N.W.)

Sezincote House and the Home Farm are supplied by a private undertaking. The source of supply is a spring thrown out by the Upper Lias clay in a wood near what is locally known as "The Sheep Barracks." The water is forced up by a ram to a reservoir near 'The Grattons Quarry.'

Warren Farm and Worcester Cottages are supplied with water from a spring thrown out by the Upper Lias clay towards the lower end of Blessed Bottom near Warren Farm in the valley of the Dikler. The water is pumped up by a ram to a reservoir near the Stow road. The deep well (160 ft.) referred to by H. B. Woodward as "at Worcester Lodge, Batsford Park,"[1] is near Worcester Cottages in Brake Covers, but is not now in use.

A spring at Sezincote Hill is thrown out by the Snowshill Clay and runs into a pond. A well has been sunk above the spring to the clay from which the water is raised by windpump to the house (analysis, p. 271).

Sherborne—Maps: 235; [44]; (36 N.E., S.E., 37 N.W., S.W.)

Sherborne village is supplied from springs thrown out by the Upper Lias clay in various situations. The Haycroft Spring, which issues from the bank on the south side of the stream about ¼ mile west of Haycroft Farm (about a mile in a west-north-westerly direction from Sherborne) supplies Haycroft Farm. Water from this spring, E. G. Hampshire informs me, is also pumped to supply the Oranges Farm, Ewepen Buildings, Woeful Lake Farm,[2] and the western part of Sherborne village, around the Smithy. A spring at Northfield Farm, to the north of the brook, supplies the eastern end of the village. There is also a spring, thrown out by the Fullers' Earth, in the field known as 'Patches,' which supplies another part of the village. Sherborne Park is supplied by gravitation from a spring in the Pleasure Grounds, and by springs below the house, water from which is pumped by a ram.

The Home Farm and Hill Barn are supplied from the reservoir (15,000 gallons), which is connected with the Camp reservoir (36,000 gallons), which belongs to the Windrush Mill Supply (p. 174).

Lodge Park is supplied from the Arnold Springs, springs thrown out by the Fullers' Earth in Sally Coppice.

Broadmoor Farm and Cottages are supplied from a boring through Inferior Oolite to the Upper Lias at Sandy Hill.

Northfield Barn is supplied by a spring near by, water from which also gravitates to the eastern part of Sherborne village.

Shipton Oliffe—Maps: 217, 235; [44]; (27 S.E., 35 N.E.)

Shipton Oliffe village is supplied mainly from a strong spring, locally called "Well Head," which has never been known to fail and is one of the finest in the Cotteswolds, in the village near South Farm. A pipe from this spring supplies standposts. A ram forces some of the Well Head water to the top of South Farm house. Shipton Oliffe Manor has water laid on from a spring, thrown out by the Fullers' Earth, at Fletchers Buildings, but in 1921 it ran so feebly that water had to be fetched from Well Head.

A streamlet, dry in summer, rises at Pen Barn, receives water from a spring at Tottmoor, and flows into a pond at the north-eastern end of Shipton Oliffe village. In October, 1921, this pond, E. G. Hampshire informs me, was practically dry, but springs rise around it. The pond-water works a ram which drives spring-water to supply Upper Farm.

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[1] 'The Jurassic Rocks of Britain,' vol. iv, (*Mem. Geol. Surv.*), 1894, p. 504.

[2] A traditional name dating back to the Civil Wars. A field near by is called the 'Bloody Field' from a like cause.

Part of Shipton Sollers is supplied, according to Mr. Hampshire, from a spring at Andoversford.

The following are supplied by springs thrown out by the Fullers' Earth :—Hill Barn ; Lower Hampen, by gravitation, per pipe, from spring ; Hampen House, small spring north-west of house ; Soundborough, by gravitation from a spring near by.

The farm buildings, once a factory, attached to Hampen House, are supplied by a deep well through the Great Oolite to the Fullers' Earth. The water is pumped to a tank and the inhabitants of Hampen Cottages have to fetch their water therefrom.

Shipton Moyne—Maps : 251 ; [34] ; (65 N.E., S.E., 66 N.W., S.W.)

The village is on Forest Marble. Originally it was dependent on wells, particulars of some of which are given on pp. 144-6. At the present time it is supplied by an undertaking of Lord Estcourt's. The source of supply is an unsteined well, distant about 10 yds. from the lake in the grounds of Estcourt House, the water from which is pumped to a reservoir (120,000 gallons) near Long Newton Church, from which it gravitates to standposts, fitted with taps, in Shipton Moyne village.

FIG. 6.—*Map showing sites of wells and springs in the vicinity of Shipton Moyne.*

SHIPTON MOYNE SCHEME, WEST GLOUCESTERSHIRE WATER COMPANY.

R. H. Tiddeman was engaged to look for a water-supply either by impounding or sinking on the portion of the South Cotteswolds roughly circumscribed by Cold Ashton, Hawkesbury Upton, Leighterton, Lasborough, Chavenage, Tetbury, Westonbirt, Luckington, Nettleton, North Wraxall, Marshfield, to Cold Ashton again.

In a letter dated 24th Oct., 1913, to H. B. Woodward, he wrote :—" The villages seem mostly dependent for retention of supplies on irregular thin beds of clay in the Forest Marble or [Great] Oolite which at their edges let the water down to lower levels, but do not make streams," and reported (10th Oct., 1913) : " My method was to follow all the valleys down until I came to some part in each where springs were coming out and forming a continuous stream of water in the course below. . . . Another source for learning summer levels was open to me in deep wells, but there are very few and the information mostly inaccessible, yet I have accounts of several from which one may get to know the ' rest-level ' of the water when pumping is not going on. . . . The existence of the thin clays of limited extent is probably responsible in the streamless area for the local water supply of several villages, the clay supporting a limited sheet of underground water which is utilized by shallow wells."

In the course of his investigations Tiddeman obtained particulars of many wells, etc., which are given below.

Tiddeman was of opinion that a good place to sink was near the village of Shipton Moyne.

Particulars of Wells and Springs in the neighbourhood of Shipton Moyne. By R. H. Tiddeman.

No. of Well	Situate at	Levels above O.D.			Remarks
		Surface	Water-levels	Bottom of Well	
1	Tetbury Pumping Station	444·06	206·00	144·06	See p. 198
2	Underbridge Cottages				Fails every dry summer ; dry for 3 months in 1913
3	Rattle Spring ...		289·00		Failed for 2 months in 1913
4	Estcourt House—Upper Lake ...	291·80	285·80	279·30	
5	Lower Lake ...		274·71	268·80	
6	Ivy Cottages ...	322·52	309·77	308·52	Fails in all dry summers
7	S.W. of Estcourt House	364·00			Dry at 318·42 ft., staging prevented getting deeper. Out of use for over 40 years
8	Sleights Cottages	349·35	345·77	337·10	Fails in dry summers. Rock close under surface.
9	Westonbirt—Home Farm	395·77	334·77	263·77	Well fills nearly to top in wet seasons

No. of Well	Situate at	Levels above O.D.			Remarks
		Surface	Water-levels	Bottom of Well	
10	Westonbirt—Home Farm		303·77		Standing water-level in 1911 had practically no impression made on it by pumping
10	E. of Clayfield Farm	376·02	372·27	364·27	Water gets low, but does not fail
11	,, ,,	374·87	370·12	366·04	Fails every dry summer. Walled for 5 ft., then rock
12	,, ,,	374·95	370·95	366·70	Dry every summer
13	Hill Court ...	379·08	312·50	289·40	Dry during summer of 1911; and for a month during 1913.
14	Westend Farm ...				Sealed well: only a top-water well
15	Pond Farm ...	351·60	348·26	340·60	Fails every summer
16	Shipton Moyne ...	343·98	339·32	336·98	
17	,, ,,	332·45	329·20	323·95	
18	,, ,,	329·33	326·58	320·83	Water never fails. When Water-works standpipes are frozen over this well supplies whole village with drinking water
19	,, ,,	331·38	326·72	323·38	
20	Cranmore Cottages	335·50	332·17	323·66	Never any water in summer and not drinkable at any time
21	Shipton Moyne ...	337·17	333·63	326·47	
22	,, ,,	328·60	325·35	319·85	
23	Hodges Cottages	328·88	315·30	301·22	Walled about 5 ft. down, then rock. Fills to within 2 ft. of top in winter, gets low in summer but always some water
24	,, ,,	326·02	314·52	304·27	Fills up almost to top in winter; never less than 4 ft. of water in well
25	Fosse Kiln		306·53	303·53	Water tank in bottom of old clay-pit—dry in summer

No. of Well	Situate at	Levels above O.D.			Remarks
		Surface	Water-levels	Bottom of Well	
26	Fosse Kiln	321·80	317·47	303·22	Fails in dry summers, dry nearly all summer of 1911
27	S.W. of Brokenborough		242·30		Water - level as issuing from well at Pumping Station now being erected for Brokenborough
27	,, ,,		241·30		River-level at above site
28	Fosse Cottages ...	311·91	306·50	293·84	Water-level very low in Sept. and and Oct., 1913: quite dry in 1911
29	N. of Upper Fosse Farm	309·90	307·90	301·90	Walled dip well
30	Upper Fosse Farm	318·00	314·76	293·34	Never short of water
31	Sherston Pumping Station	417·04	313·54	290·70	A borehole is said to have been sunk 450 ft. below surface
32	Hancock's Well	324·20	319·62	317·87	A very strong spring, never fails. River-level 319·30

Operations were accordingly commenced. First test-sinkings, in the form of a shaft and two borings, were made. Details of the geology obtained from these have been published.[1] Subsequently the drilling of the permanent tube wells was proceeded with. Progress was slow owing to the War and later the scheme was put in abeyance.

No. 3 Boring, Shipton Moyne Pumping Station.—Commenced 12th Feb., 1916; finished 20th July, 1916.

Top of bore, 311·37 ft. above O.D., Percussion boring, 25 ft. 6 in. deep, Rotary boring, 417 ft. 6 in.: total depth 443 ft.

	Thickness Ft.	In.	Depth Ft.	In.
1-2. Surface soil and "clay with grey stone and a thin bed of bluish rock at the base" ...	6	6	6	6
3*a*. "Beds of blue rock"	11	0	17	6
b. "Brown sandy loam" ...	0	3	17	9
c. "Blue clay	2	3	20	0
4 to 19. "Blue rock (hard) with bands of blue clay"	5	6	25	6
Limestone, etc., similar to those composing beds 4-19 proved in No. 1 Bore: about	19	5	44	11

[1] L. Richardson, *Proc. Cotteswold Nat. F. C.*, vol. xix, pt. 1, 1915, pp. 49-55.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Forest Marble (74 ft.)	20 to 22. A variable series of deposits similar to those composing beds 20-22 proved in No. 1 Bore	10	7	55	6
	23 to 25. Typical Forest Marble: about	12	6	68	0
	26 to 32. Bradford Clay (stratigraphical position of). Grey shaly clay with occasional very thin layers of sandy limestone that are frequently covered with "tracks" ...	6	0	74	0
Great Oolite (79 ft.)	Limestones, oolitic, hard, bluish-grey at the top, but the main mass is softer and of a grey tint. Seams of clay are stated to occur between some of the constituent beds ...	21	0	95	0
	Coral Bed. Limestone, yellowish; ? *Cladophyllia, Lima cardiiformis* Morris and Lycett, *Serpula* sp.	1	4½	96	4½
	(At 95 ft. down a 'strong fissure' was encountered).				
	Great Oolite Limestones. (*a*) Limestone, cream-coloured but with a pinkish tinge... ...	1	4½	97	9
	(*b*) Limestone similar to (*a*) ...	0	10	98	7
	(*c*) Limestone, grey, oolitic ...	0	9	99	4
	(*d*) Limestone, dark grey in the top portion	2	6	101	10
	(*e*) Limestones, yellowish, oolitic ...	51	2	153	0
	(The water in the borehole was lost at 153 ft.)				

Beds similar to those proved in No. 1 boring, namely :—

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
42. Light-grey limestone, 'sparry,' obscurely oolitic. The bottom foot or so is of a yet lighter grey tint with irregularly distributed white oolite-granules	9	4	162	4
43. Yellowish oolite	1	1	163	5
44. Grey impure limestone (having films of blackish shale associated with it) and very sparsely oolitic	5	11	169	4
45. Dark-grey, sandy, shaly rock—the sandy matter and films of shale alternating irregularly	2	6	171	10
46. Dark marl, with occasional irregularly-developed limestone layers in the top portion. The middle portion soon breaks up on exposure ...	5	3	177	1
47. Marl, similar to 46	1	0	178	1

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
"Passage Beds" (61 ft. 6 in.)	48*a*. Rock and marl similar to the upper part of 46	6	0	184	1
	b. Dark, shaly, sandy marl (very similar to 45), with subordinate layers of impure limestone	5	3	189	4
	c. Very light-grey, fine-grained, impure limestone, sandy to the touch	4	9	194	1
	49*a*. Very light-grey, fine-grained, impure limestone, sandy to the touch, with an occasional white oolite-granule, casts of lamellibranchs, and a *Rhynchonella* of the *R. concinna* group	3	3	197	4
	b. Limestone, very similar, but more calcareous and therefore harder, with blackish, irregular and sporadically distributed oolite-granules; *Lima* sp. Some of the black specks in this rock were ascertained by Mr. F. R. Ennos to be iron pyrites...	4	6	201	10
	c. Marly rock	1	6	203	4
	d. Impure limestone	0	6	203	10
	50. Indurated marl	3	0	206	10
	51. Light-grey, very coarsely oolitic, rather softer limestone; *Entolium demissum* (Phil.) ...	5	4	212	2
	52. Limestone, very similar to 51, but softer and pisolitic ...	1	0	213	2
	53. Light-grey, fine-grained, slightly sandy limestone—a conspicuous stratum	1	4	214	6
	54. Marl, black, shaly, *without* fossils	5	2	219	8
	55. Shelly limestone in irregular layers with intervening irregular layers of marl. Crowded with small specimens of *Ostrea acuminata* J. Sow., *Chlamys vagans* (J. de C. Sow.) *Rhynchonella* of *R. concinna* group ... ... A hard conspicuous stratum practically composed of the valves of *Ostrea acuminata* Sow. embedded in a white matrix occurs at 224 ft. down.	13	2	232	10
	56. Limestone, grey, less shelly than those in deposit 55	0	10	233	8
	56*b*. Marl, shaly, greenish-grey, *relatively barren*; two sandy ½-in. layers near the top, and *Ostrea acuminata* Sow. common in the lowest 4 in.	3	0	236	8

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Fullers' Earth (85 ft. 6 in.)	57. Hard, blue, shelly limestone (similar to 59*b*) with irregular intervening layers of shaly marl; *Ostrea acuminata* Sow. common	1	6	238	2
	58. Marl, shaly, dark in the upper portion, greenish-grey in the lower. More sandy and indurated at the top: *relatively barren*	10	0	248	2
	59*a*. Marl, dark at some horizons, greenish-grey and more marly at others, with occasional thin blue shelly limestones in the upper part and full of specimens of a small form of *Ostrea acuminata* Sow.; *Chlamys vagans* (J. de C. Sow.)	3	5	251	7
	b. Hard, blue, shelly limestone ...	1	0	252	7
	c. Greenish-grey indurated marl full of shells	0	7	253	2
	d. Grey shaly marl, *relatively barren*, only an occasional *Ostrea acuminata* Sow., *Rhynchonella* of *R. concinna* group	1	1	254	3
	e. Limestone, similar to *b* ...	0	5	254	8
	f. Greenish-grey marl and clay, dark shaly marl, and greenish-grey indurated marl full of shell-fragments: *Ostrea acuminata* Sow. common in the soft portions	1	7	256	3
	60. Dark shaly marl, *relatively barren* with an occasional fine-grained grey sandy layer ...	8	8	264	11
	Limestone, grey with numerous small crinoid-ossicles ...	0	1	265	0
	Fullers' Earth.—Greyish marl, weathering into small shaly pieces of very uniform texture, devoid of hard layers and unfossiliferous	35	0	300	0
Inferior Oolite (75 ft.)	62. Rubbly beds. Limestone, hard, somewhat crystalline and sparsely oolitic, rubbly in places; *Entolium demissum* (Phillips), *Serpula* sp. ...	4	6	304	6
	63. Shipton Moyne Sand ... ... (Water commenced running over the top of the borehole when it was 310 ft. 6 in. deep)	13	6	318	0
	64, 65. Doulting Stone. 64. Limestone, oolitic, few fossils—*Entolium demissum* (Phillips)	6	6	324	6
	65. Limestone; *Terebratula globata* auctt., *Entolium demissum* (Phillips) common in the more rubbly top-portion	3	0	327	6

		Thickness Ft.	In.	Depth Ft.	In.
	Non-sequence. Upper Coal-Bed and Dundry Freestone wanting.				
	66. Upper Trigonia Grit. Ragstone; usual fossils	3	6	331	0
	Non-sequence. All the beds of the hemerae *niortensis* to *bradfordensis* (inclusive) wanting.				
	67. Pea Grit. Typical pisolite, bluish-grey. The top portion is well bored by annelids ...	22	0	353	0
	68. Lower Limestone	21	8	374	8
	69. (?*scissi* hemera) Pecten Bed. Grey, fine-grained, micaceous sandstone, full of specimens of *Entolium demissum* (Phillips) *Variamussium pumilum* (Lamarck), and *Pseudomonotis* sp.; *Amberleya ? capitanea* (Goldfuss), *Gervillia* sp. ...	0	4	375	0
	Non-sequence here if the Pecten Bed is of *scissi* hemera.				
Upper Lias	Cotteswold Sands. (*a*) Sands, grey;	43	0	418	0
	(*b*) Sands, dark-coloured, hard, argillaceous; proved ...	25	0	443	0

Bottom of borehole.—131·63 ft. below O.D.

The cores from this boring showed a sharp line of demarcation between the shaly clays (beds 26 to 32 of the Forest Marble) and the underlying Great Oolite limestone.

The 'Passage Beds' commence at 153 ft. down. They resemble their equivalents in No. 1 Borehole, certain beds differing only in a few matters of detail. The particulars given were obtained from the cores drawn from No. 1 Borehole, but an adjustment has been made in the thickness of bed 51 to allow of the base of the Passage Beds being at 214 ft. 6 in. down—the depth of the actual base in No. 3 Borehole.

In No. 3 Borehole the beds grouped as Fullers' Earth were also similar to their equivalents proved in No. 1. An adjustment has been made in the thickness of bed 60[1] so as to allow of the base to be at 265 ft. down—the depth of the actual base in No. 3 Borehole.

Henry Marten, late Engineer and Director, West Gloucestershire Water Company, informed me that only two of the bores were tapped and while pumping a short time obtained about 1½ million gallons per 24 hours: "as far as I could tell that appeared to be about the yield; that was all our pump was capable of doing" (12th July, 1921). An analysis of water from No. 3 Borehole is given on p. 272.

Well at Hill Court.—(No. 13 on sketch-map, fig. 6, p. 143).

Surface-level, 379·08 ft. above O.D.

	Depth. Ft.	In.
Well (6 ft. diameter):—		
Forest Marble ... ... } Great Oolite ... ... }	89	8

R. H. Tiddeman ascertained that this well was dry during summer of 1911; and for a month during 1913.

[1] The thickness of bed 60 in No. 1 Borehole was erroneously given as 7 ft. 10 in. in *Proc. Cotteswold Nat. F. C.*, vol. xix, pt. 1, 1915, p. 52; it should have been 8 ft. 10 in.

When this well was sunk some water was encountered at 38 ft. down, issuing probably from above the basal clay-bed of the Forest Marble, the deposit numbered 26-32 in the record of the rocks penetrated on the Shipton Moyne site, but was lost at 40 ft. down. In wet weather water pours down the well-side from this horizon. It had been intended by the well-sinkers to go down to the same depth (126·34 ft.) as the Sherston Pumping Station well (31 on map, fig. 6, p. 143), but when they got down to about 90 ft. the quantity of water was considered adequate by those for whom they sank the well. It is said, however, that in dry weather the water-table sinks below the bottom of the well.

Shurdington—Maps: 216, 234; [44]; (26 S.W,. S.E., 34 N.W.)

A. J. Stephens, formerly of Badgeworth Court, near Cheltenham, has communicated the following particulars concerning the water-supply of the village, which is for the most part on superficial sand and gravel :—

Site	Depth of well in ft.	Formation in which sunk
Shurdington Lodge	10	gravel
,, ,, ...	11	,,
New Inn	8	,,
,, Lane (12 cottages)	8	,,
Ivy Cottages	8	,,
Organ's house	8	,,
Sadler's ,, ...	8	,,
Bayley's ,, ...	8	,,
Wentworth	8	,,
Pool Farm	15	,,
The Lawn	15	sand
,, (stable use)	11	,,
Poplar Farm (various cottages use this supply) ...	15	,,
Pick's Cottage	8	gravel
King's Head Inn	11	,,
Church Farm	8	sand
The Vicarage	12	,,
Blenheim Cottage	8	,,
School		(Rain water)
Dutch Villa[1]		(Spring)
Six small houses between Leckhampton and Hatherley Lames	8	Lower Lias
Hafod		
Chargrove Lane	30	,,
Oak House	30	,,
Oak Farm	30	,,
Chargrove Lane	30	,,
Chargrove		No water
The Greenway		(Spring)
Little Shurdington :—		
Selby's Farm	12	
2 cottages	10	
South's Farm	10	
2 cottages	10	
The Green (Mr. Hitch's)		(Spring)

[1] A boring, said to be 200 ft. deep, was made in the Lower Lias here, but it did not yield any water.

Siddington—Maps: 235, 252; [34]; (51 S.W., S.E., 59 N.W., N.E.)

E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council, informs me:—"This village is very scattered. The inhabitants obtain their supply from wells mostly in the gravel [analysis, p. 273]. The majority of the wells gave a very fair supply in 1921, but some were low. Council Houses.—Well about 22 ft. deep. Brashy soil at top, layer of blue clay, to blue rock (6 ft.).

"Siddington House and four cottages are supplied from a dug well (50 ft.) and borehole (49 ft.—6-inch diameter), penetrating:—

		Thickness Ft.	Depth Ft.
	1. Clay and marl[1]	34	34
? Forest Marble	2. Clay	17	51
	3. Clay and stone	9	60
	4. Blue stone	14	74
	5. White stone	13	87
	6. Blue marl	1	88
? Great Oolite	7. Stone	4½	92½
	8. Soft white stone in which water was struck which rose to within 46 ft. of surface	1½	94
	9. Blue stone	5	99

"When the well was 88 ft. deep it had 4 ft. 6 in. of water in it.

"Worms Farm is supplied from slow-running springs the water from which is conveyed to a reservoir about 20 ft. by 10 ft. by 6 or 7 ft. and is raised to a storage tank at the farm, from which it gravitates to the farm, two cottages and the Round House. The yield was good during 1921."

Siston—Maps: 265; [35]; (72 S.E., 73 S.W.)

Crown Pit, Warmley, penetrating 500 ft. of Coal Measures, has been described by H. B. Woodward.[2]

Slimbridge—Maps: 234; [35]; (40 S.W., S.E., 48 N.W., N.E., S.W., S.E.)

The village is on gravel and is dependent on wells from 10 to 15 ft. deep, the water in which has not been considered good by the last three Medical Officers of Health, and in some cases is saline.

Boring at Wisloe.—Made in 1920 to supply County Council Cottages (Small Holdings), but no water was obtained and a supply was laid on from the Coaley undertaking. The boring was 80 ft. deep and penetrated gravel and Lower Lias clay.

Snowshill—Maps: 217; [44]; (14 N.W., S.W., S.E.)

Springs are thrown out by the Upper Lias clay and the village is supplied by these or by wells. Thus a well sunk by the Winchcomb Rural District Council is about 18 ft. deep and has a pipe laid from the bottom to two stand-posts supplying a row of cottages south of the church. A shallower well near the Manor House supplies the row of cottages to the west. A spring north-west of the Manor House yields about 120 gallons per hour.

In the Inferior Oolite Series of the high ground, roughly between the Freestone and Ragstone divisions, is a bed of clay called the Snowshill Clay, which throws out the following springs:—1. At 1,000 yds. N.16°E. of Snowshill Hill. The water is piped to near a barn to the south-east by east,

[1] Siddington House is represented on the geological map as being on Cornbrash.

[2] 'Geology of East Somerset and the Bristol Coal-Fields' (*Mem. Geol. Surv.*), 1876, p. 39.

where there is a ram which forces it up to Snowshill Hill. 2. At a cottage some 1,350 yds. east by north of Snowshill Hill. It originates a streamlet that trickles down the valley-side and then sinks in. 3. At Smallthorns. 4. At 440 yds. east-south-east of Snowshill Hill, the water of which is piped to supply Horn's Leazor. The overflow runs into the pond there and thence into the ground. 5. At Snowshill Hill. It originates a streamlet that trickles down the valley-side and then sinks in.

Somerford Keynes—Maps: 252; [34]; (59 N.W., S.W., N.E., S.E.)

The village is for the most part on gravel and obtains its supply from wells, rarely exceeding 9 ft. in depth, sunk therein. At the Manor Farm is a well (sunk in 1914) about 20 ft. deep, yielding a good supply of water, which is raised for the house and farm-buildings.

Shorncote hamlet comprises two farm houses and five cottages, which are dependent on wells. The well at Shorncote Farm continued to yield throughout 1921; but those at the other places failed in the latter part of that year.

Southam-and-Brockhampton—Maps: 216, 217; [44]; (19 S.E., 20 S.W., 27 N.W.)

From a well about 15 ft. deep in gravel immediately east of the Honeybourne Line (G.W.R.) a wind-pump raises water to Kayte's Farm and Cottages. In the farm-yard near the church is a pump over a well said to be about 12 ft. deep and in gravel.

The hill-portion of the parish embraces Cleeve Common. The prevalent dip of the beds is easterly. Therefore little water issues from the western face: it comes out in the valleys in the eastern portion, Dry, Watery (source of Postlip Brook) and Padcomb (source of Isbourne) Bottoms. G. H. Phillott communicated the following gaugings:—

	Gallons per day
Spring from Dry Bottom	9,000 to 13,000
Water from spring conveyed by pipe into trough at Postlip Hall	18,000 to 19,000

There are a few wells in use in the village of Southam, but the main supplies are derived from springs issuing from the broken ground on the western face of Cleeve Hill. Water is derived from three separate sources: Southam de la Bere House obtains its supply from a spring at Nutters' Wood, which is conducted into a series of small reservoirs; the house and troughs near the tramway shelter from another spring; while the large houses in the parish by the side of the road up Cleeve Hill, the gardens of Southam de la Bere House, cottages and standposts in the village, Pigeon House Farm, etc., are supplied from a spring in Thrift Wood.

A well in a field called 'Bitmore,' Haymes Farm, is 20 ft. deep in Lias. The water-level fell 6 ft. in 1921 owing to the drought. Water is raised by a wind-pump to supply Haymesgarth and Haymes Road.

Brockhampton, a hamlet of 5 houses, obtains its water from the gravel on the higher ground to the north which lies between The Grange and Wigmore Farm. R. C. S. Walters informs me that "The water is collected in a well a quarter of a mile north of the hamlet whence it is piped to Mr. Holder's Farm where there is a water tank from which most of the inhabitants draw. There was some shortage in 1921; but the brooks in the neighbourhood were drawn upon for washing purposes."

South Cerney—Maps: 252; [34]; (51 S.E., 59 N.E., S.E., 60 N.W., S.W.)

South Cerney village is dependent on wells, mostly about 10 ft. deep, sunk into gravel. The wells on the north side of the Churn contained water

throughout the drought of 1921 ; but the majority of those on the south side ran out and water had to be carted from the Boxwell Springs.

Cerney Wick is dependent on wells up to 10 ft. in depth, which is probably the thickness of the gravel. The gravel is full of water, but the wells ran low in 1921.

Boring at the Manor House.—North-east of the Post Office. Sunk 1887. Still in use. Particulars communicated by the late Prof. E. Kinch in 1888 to H. B. Woodward.[1] Top of borehole about 300 ft. above O.D.

		Thickness Ft.	Depth Ft.
	1. Gravel	18	18
Oxford Clay	2. Sandy clay	31	49
Kellaways Rock	3. Calcareous sandstone ...	2	51
	4. Sandy clay	3	54
	5. Blue clay	15	69
	6. Blue sandy clay ...	21	90
	7. Calcareous sandstone with *Ostrea*, *Terebratula*, lignite	8	98
	8. Shelly marl	6	104
	9. Calcareous clay	7	111
	10. Fine sand	3	114
	11. Blue calcareous sandstone passing down to pure clay	10	124

The water just trickled over the tube in the borehole immediately after it had been sunk in 1887, but now rises 4 to 6 ft. above the level of the ground.

When bored : yield at 70 ft. was 3,280 gallons per 24 hours.
,, 87 ft. ,, 8,640 ,, ,,
,, 110 ft. ,, about 10,000 gallons per 24 hours.

Present yield, 10,000 gallons a day. V. A. Lawson, Cirencester, states that the water is very soft (analysis, p. 273).

Boring at Mineral Water Factory.—In field behind the Post Office. Sunk 1893. Particulars communicated by E. J. Mathews, Sanitary Inspector, Cirencester Rural District Council.

		Thickness Ft.	Depth Ft.
	1. Gravel	10	10
[Oxford Clay]	2. Clay	41	51
[Kellaways Rock]	3. Some soft material ...	32	83
	4. Brash	7	90

Water rises 4 to 6 ft. above the level of the ground.

Boring at Barston House.—This boring is to the south-west of the preceding and used to supply a Brewery. It now supplies Barston House and a number of cottages near. It is 60 ft. deep and would therefore appear to enter the Kellaways Rock, bed 3 of the Mineral Water Factory boring. The water overflows at the surface.

Well at Cerney and Ashton Keynes Station.—About 20 ft. south of the south end of the station building. Communicated by E. Connal, on 28th June, 1921. Ht. above O.D.—290·3 ft. Depth of well (sunk through soil into gravel).—8 ft. Bottom of well.—284·3 ft. above O.D. Rest-level of water, 27th June, 1921.—284·3 ft. above O.D.

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[1] 'The Jurassic Rocks of Britain' vol. v (*Mem. Geol. Surv.*), 1895, p. 35.

The well supplies water for station purposes only. The hand-pump is capable of raising 200 to 300 gallons an hour. The water is probably mainly derived, through the gravel-bed, from the River Churn, which is only 800 ft. or so away. No knowledge is possessed of any notable variation in yield.

Well at West Down.—E. J. Mathews informs me that at West Down, near Worms Farm, is a well 15 ft. deep, through 10 ft. of gravel into blue clay, the water from which is raised to a tank in the roof of the house. "There is a similar supply at Hales Farm (south of West Down), which is a new house not marked on the map."

Boxwell Springs.—These springs issue immediately below the south retaining-bank of the now derelict Thames and Severn Canal, three-quarters of a mile E. by N. of South Cerney Church. A fault, trending roughly W. by N. and E. by S. runs along the line of the canal here. By it, a surface of Oxford clay on the south has been brought on a level with Forest Marble on the north. Above the Forest Marble is a stretch of Cornbrash of considerable extent.

Sometimes, as during the drought of 1921, when the River Churn had gone dry from above Cirencester to the inflow of the Boxwell Brook, the Boxwell Springs were still flowing normally—the water running, *per* the Boxwell Brook, into the Churn.

J. H. Taunton,[1] and apparently John Bravender,[2] held that the Boxwell Springs are maintained by water lost to the Churn above Cirencester by soakage into the permeable Cotteswold Sands and Inferior Oolite (see p. 42) that pursues an underground course, and rises in artesian manner here up the fault-plane. The present writer, however, agrees with the opinion expressed by Dr. T. Wright and D. J. Humphris (who investigated the springs in connexion with a search for an additional source of supply for Cheltenham[3]) that they are the product of the drainage of the Cornbrash tract to the north. It may be legitimately assumed that when the canal was constructed provision was made for the main Boxwell Springs to pass under it without damaging the work.

J. H. Taunton has given the following gaugings :—[4]

	Gallons per day.
5th and 6th August, 1864 (during a period of drought)	1,108,000
10th October, 1864	1,121,758
20th July, 1886 (with some leakage at the gauge-board)	1,035,000

When the amount of dissolved solid impurities in the Boxwell Springs is compared with those of the Seven or Cowley Springs it is found to be about half as much again.

Springs	Temp. Faht.	Total solid impurity	Organic elements	Hardness	Remarks
Seven Springs ...	50·36	22·60	·021	16·9	Clear and palatable
Cowley ,, ...	50·00	24·32	·032	19·4	,, ,,
Boxwell ,, ...	51·44	33·86	·068	26·7	,, ,,

[1] *Proc. Cotteswold Nat. F. C.*, vol. ix, for 1885-86, pp. 70, 71.

[2] *Rep. Roy. Comm. Water Supply.*—Min. Evidence, Appendix H, p. 42.

[3] *Rep. Add. Supply Water to the Town of Cheltenham*, 1863, pp. 19, 20.

[4] *Proc. Cotteswold Nat. F. C.*, vol. ix, pp. 70, 71. The Boxwell Springs are pictured in *idem*, vol. xxii, pt. 1 for 1924 (1925), pl. i, fig. 2. See also *Proc. Geol. Assoc.*, vol. xxxvi, 1925, pp. 89, 90.

Southrop—Maps: 235; [34]; (53 N.W., S.W.)

Southrop village, which is the property of Corpus Christi College, Oxford, is dependent on wells, some draw-wells, others fitted with pumps. The majority are shallow wells sunk into the Cornbrash (which is about 16 ft. thick). Some of the wells are deeper, however, and no doubt enter the Forest Marble. An example of one of the deeper wells, a draw-well, is that at Box Cottage. It is 30 ft. deep and on 23rd Aug., 1922, water stood in it at 5 ft. below ground-level.

Standish—Maps: 234; [43 S.E.]; (41 N.W., S.W.)

Lord Sherborne had reservoirs constructed above Standish Park to hold 60,000 gallons of water obtained from a spring issuing from the base of the Cotteswold Sands, a quarter of a mile north by east of Standish Park Farm, to supply the whole of the Standish Estate, which comprised sixteen large farms and about sixty cottages. Wells in use in the Lower Lias of the vale are from 15 to 25 ft. deep and yield water sufficient in quantity and satisfactory in quality.

Oxlinch obtains its water from wells and springs and there are springs at Arebrook and Vinegar Hill.

Stanley Pontlarge—Maps: 217; [44]; (20 N.W.)

The parish is supplied by wells and springs, the Manor Farm having a piped supply from a reservoir catching spring water issuing from the flank of the hill between the Farm and Stanley Wood.

Stanton—Maps: 217; [44]; (13 N.E., S.E., 14 N.W., S.W.)

The village is supplied by an undertaking provided by Sir P. S. Stott. The source of supply is springs thrown out by the Upper Lias clay. The water is conveyed into an open reservoir (1,012,000 gallons) from which it gravitates to the village.

Stanway—Maps: 217; [44]; (13 S.E., 14 S.W., S.E., 20 N.E., 21 N.W.)

The highest spring is a little below the 700-ft. contour line, and this is about the altitude of the base of the Cotteswold Sands. The reservoir at the spring-head belongs to the Evesham and Pebworth Villages Joint Water Committee (p. 157). The chamber immediately to the north of it taps another spring, the water from which is conveyed into the pipes from the reservoir as an auxiliary supply. The two rams to the west pump water up to Taddington. G. H. Phillott informed me that in August, 1911, a very dry summer, the main spring was flowing 369,000 gallons a day: a spring at a lower level, 80,000 gallons a day. On 21st May, 1922, the overflows from the springs used for the purposes of supplies and the minor springs was at the rate of 280,000 gallons a day.

Between the Wood and Papermill Farm is a copious spring which runs into a stone trough in front of Spring House. On 21st May, 1922, the flow of water into the road-side trough was at the rate of 30,000 gallons a day.

Stanway village is supplied from a spring ("The Reeds Spring") in Old Hill Plantation (often spoken of locally as "The Reeds Cover"). The water is piped to a reservoir, thence to the village. Chas. A. S. Collyer, Agent of the Toddington Estate, informs me that the surplus water supplies the glass-houses, Burberry Hill House, The Lydes, Raymeadow Farms and Cottages and another portion of Toddington village.

Stanway House is supplied from a spring in the ground called 'Malpas.' Wood Stanway hamlet has a piped supply from a spring at Thrift Wood.

Evesham and Pebworth Joint Water Committee.—This scheme was approved and carried out in 1895 and in 1913 a considerable augmentation of the supply was effected by the addition of six springs situate in Lidcombe Wood on a 99 years lease from Lord Elcho.

Supplies :—Aston Somerville, Cow Honeybourne, Hinton-on-the-Green, Pebworth (Pebworth R.D.C.), Long Marston (Marston Sicca R.D.C.)—Glos. : Aldington, Badsey, Bretforton, Church Honeybourne, Cleeve Prior, Great and Little Hampton, Harvington, North and South Littleton, Offenham, Sedgeberrow and Wickhamford—Worcs.

Source of Supply :—Springs thrown out by the Upper Lias clay in Lidcombe Wood, Stanway. The actual appearance of the water from this horizon is often at a somewhat lower level than it should be owing to slipped Oolite. The quantity of water obtained is, R. J. Atkinson, Surveyor to the Pebworth R.D.C., informs me, at least 300,000 gallons a day.

Works :—The springs are tapped by headings driven into the hill and brought to two small collecting chambers—the second of which, a little below the 600-ft. contour line—was constructed in 1913. No storage is necessary. From the chambers the water is conveyed to the different villages in Gloucestershire in cast-iron mains. There is no filtration. The average daily quantity of water supplied is 120,000 gallons and the supply is more than sufficient and constant.

Quality of Water :—Excellent for drinking purposes, being perfectly pure and free from any sort of contamination (analysis, p. 274). No Plumbo-solvent action and periodical samples are taken to test its freedom from any contamination.

Staunton—Maps ; 233 ; [43 S.W.] ; (30 S.W., S.E., 38 N.W., N.E.)

Staunton village, together with the parish, as a whole, is dependent on wells.

Staverton—Maps : 216 ; [44] ; (26 N.W.)

Some 57 out of 99 houses in the parish, according to the L.G.B. Return, 1915, are supplied with Cheltenham Corporation water. Houses not so supplied are dependent on wells, supplemented in some cases by rainwater storage.

F. A. Middleton, Sanitary Inspector to the Cheltenham Rural District Council, informs me that a well sunk in 1921 for a new cottage in the field immediately west of the Smithy on the north side of the Gloucester Road, $\frac{1}{6}$ mile west of Haydon Court, is 20 ft. deep in " chisel " clay. The water came from a fissure in the Lias clay that was filled in with sand. There has never been less than 10 ft. of good, but hard, water in the well. On the other hand, the water in a well (20 ft. deep) in the Lias in the paddock of the farm, also on the north side of the Gloucester Road, opposite Haydon Court, is saline.

Stinchcombe—Maps : 251 ; [35] ; (48 S.W., S.E., 56 N.W., N.E.)

In Stinchcombe practically all the houses have wells, but The Fountain is made use of. The supply to The Fountain, however, is not very satisfactory. The water for it is obtained from a well in the basal portion of the Middle Lias. The Manor House is supplied from a well near to that which feeds The Fountain, the water from which is pumped to a reservoir above on Common Hill.

A well sunk at Meadowlands in Lias, 33 ft. deep with a borehole 33 ft. deep from its bottom, collected saline water. The borehole was therefore filled up and agricultural pipes laid to collect surface water into the well.

At Drakestone House a well is 126 ft. 6 in. deep with headings at about 80 ft. down, at which depth most of the water encountered entered, but it came in very slowly. Yercombes Cottage well is not far distant from preceding and is 128 ft. deep. Stancombe Park is supplied from a spring in the yard below the house (W. Webb). Stinchcombe Hill House, see Cam.

Stoke Gifford—Maps: 250, 264; [35]; (68 S.W., 72 N.W.)

Stoke Gifford is supplied, together with Harry Stoke, by the West Gloucestershire Water Company.

Stoke Orchard—Maps: 216; [44]; (19 N.W., S.W., N.E., S.E.)

This parish is on the Lower Lias, on the surface of which are locally deposits of gravel.

There is a private reservoir[1] situate near the railway on the Whittaker Estate. The reservoir resembles a pond measuring some 40 ft. by 40 ft., in which clear water stands about 3 ft. deep. The water is piped to Stoke Orchard where it feeds standposts. The supply is said to be unfailing, and comes out of a gravel-bed under chiefly arable land. The wells in the parish are from 8 to 10 ft. deep. The water they yield is said to be of poor quality. Some of the well waters are saline: Dr. Jamieson in his 'Treatise on Cheltenham Waters' (1814) mentions a draw-well, 40 ft. deep, which contains a "saline water without iron or sulphur" and with a great proportion of "sea salt."

Stonehouse—Maps: 234; [35]; (41 S.W., 49 N.W.)

Stonehouse is mainly supplied by the Stroud Water Co., but there are a few wells. Formerly a number of properties were supplied by an overflow from the Verney Spring which issues from the Sandy Beds of the Middle Lias at a little below the 300 ft. contour in a hollow some 300 yds. north-east of the Stonehouse Brick and Tile Works. Another spring issuing from the same geological horizon east of The Glen is used by the inhabitants of Woodcock Lane as an alternative supply to that laid on by the Stroud Water Company.

At Spa Inn, Oldend, there is a well, about 70 ft. deep in the Lower Lias clay which yields a saline water similar to that met with in the well at The Grange, Leonard Stanley (p. 111).

Stowell—Maps: 235; [44]; (36 S.W., 44 N.W.)

Springs (1) one in Oaks Bottom (Yanworth parish), 1⅓ miles north-west by north of Stowell House; (2) two between Oxpens and Cowlease Grove; (3) one, a little under ¼ mile south-south-west of Oxpens, feed a reservoir in Stowell Grove from which the water is piped to reservoirs (*a*) ¼ mile south-east by east of that in Stowell Grove, and (*b*) ⅙ mile south by west of the last, which supply Stowell Park House and adjoining buildings. The overflow from reservoir (*a*) supplies Oxpens Farm and Cottages' tank, but in 1921 the overflow ceased after Oct. 1st.

The springs in Stowell Park west of the House (gauged approximately by E. G. Hampshire as not less than 10,000 gallons per day) have water from them pumped by ram to some cottages ¼ mile to the north-east by east. Water from a spring in the Park to the north-west of the House supplies by gravitation a house on the Park boundary to the west by south. The springs by Dogkennel Cottages are strong (according to Mr. Hampshire about 15,000 gallons per day), and run to waste.

The houses in this parish are thus well supplied with good spring water, all of which is thrown out by the Fullers' Earth.

[1] Marked on the 1-inch map (N.S.) 216.

Stratton—Maps: 235; [34]; (51 N.W.)

The majority of the houses, including those in Stratton End, are supplied from the Cirencester Urban District Council's Waterworks.

Boring at Stratton End.—½ mile E. 17°N. of Stratton Church.

Borehole (4-inch diameter) :—

Through basement-beds of Forest Marble, Great Oolite ? to Fullers' Earth ... ... 138 ft.

The water is raised by wind-pump to a tank (1,000 gallons) for the supply of "Highfield."

Boring at School Hill.—Borehole (3-inch diameter) :—

Great Oolite ? to Fullers' Earth ... ... 60 ft.

Barker's Well.—Cheltenham Road, about centre of village.

Well (dug) :—

Great Oolite ... ... 24 ft.

Borehole :—

Great Oolite ?to Fullers' Earth ... ... 56 ft.

The yield was feeble during the drought of 1921; but in Aug., 1922, the rest-level of the water stood at 30 ft. below surface-level.

Sudeley Manor—Maps: 217; [44]; (20 S.E.)

There is no village: only Sudeley Castle and some widely separated farms and cottages. Sudeley Castle is supplied from St. Kenelm's Well; the Home Farm, Woodlands Farm and the Laundry from the Winchcomb main.

Sudeley Lodge and Sudeley Cottages have a supply from a spring in an arable field on the hill-side above and to the east the water from which is piped into a reservoir from which there is a pipe to the buildings. Similarly Sudeley Hill Cottages and Sudeley Farm are supplied from springs.

There are several good springs in the parish, notably in Spoonley Wood, water from which is forced up by ram to a little reservoir on Roel Hill from which it gravitates to Roel.

Swindon—Maps: 216; [44]; (19 S.E., 26 N.E.)

A considerable part of the village is on sand, the remaining part on Lower Lias clay.

According to the L.G.B. Return, 1915, 10 out of 62 houses are supplied with Cheltenham Corporation water. There is a village pump. Houses not served as above are dependent on wells. A well at The Lodge of Swindon Hall contains saline water.

Syde—Maps: 234, 235; [44]; (34 S.E., 42 N.E.)

Syde village, which is a small one belonging to J. Dillworth Crewdson, is supplied from a spring thrown out by the Fullers' Earth just below the village and some 200 ft. above the stream at the bottom of the valley. Water from it is forced up to two 1,000-gallon tanks in the village, whence it supplies the House, Old Rectory and a public tap for the use of the few cottagers.

Taynton—Maps: 216, 234; [43 S.E.]; (24 N.W., S.W., N.E., S.E.)

At Glasshouse Hill on the Llandovery Beds the majority of the houses have wells, supplemented by rain water storage. One well at Glasshouse Hill, which is typical, is 22 ft. deep, and on 7th Oct., 1922, had 11 ft. of water in it. The water was said never to have failed. There are various dip wells catching the water of small springs.

Temple Guiting—Maps: 217; [44]; (21 N.W., N.E., S.W., S.E.)

Temple Guiting village, with the exception of New Barn Farm, which is supplied from Broadwater (by Corpus Christi College, Oxford), is supplied from springs in Wells' Head Bottom by a scheme also provided by Corpus Christi College. Wells' Head Bottom is the valley north-east of the village, usually dry, but water emerges towards its lower end, and is impounded in a pond by the road side. The water is collected up the valley and piped to a reservoir from which it gravitates to the village. The pressure is often inadequate for the houses in the higher part of the village when those in the lower are drawing off water.

Kineton hamlet is supplied by an undertaking provided by Corpus Christi College. The source of supply is a strong spring thrown out by the Upper Lias clay alongside the road by the Windrush down in the bottom below the hamlet. The hole in which the spring issues is known as 'Joe's Hole.' The water is raised to a reservoir in the hamlet by the side of the Guiting road. The water is laid on to a few houses, but there is a pump near the reservoir for general use.

A water-wheel at the bottom of Stable Lane drives spring-water up to Bembro' (college land) and Lots Barn.

A good spring in Smith's Orchard is running to waste.

Barton hamlet has a piped supply from Kineton. There is an excellent spring thrown out by the Upper Lias clay at the foot of the bank below the old farmhouse; the water runs to waste into the Windrush. Ford hamlet has a piped supply from a reservoir fed by a spring thrown out by the Snowshill Clay in the valley side to the west-south-west. There are, however, several wells: that in the yard of The Plough Inn is 30 ft. deep.

In the Inferior Oolite of the high ground of the eastern portion of the parish the Snowshill Clay is of importance from a water-supply standpoint. Water from a spring 750 yards north by east of Trafalgar is piped to a windpump which raises it to a reservoir at the cottages near the farm buildings. Another spring close by runs into a reservoir (below ground) from which Guitinghill Farm is supplied. Down in the valley below (east of) Trafalgar two springs issue, the water of which is impounded in a cement-lined pond.

Tetbury Upton—Maps: 251; [34]; (57 S.E., 58 S.W., 65 N.E., 66 N.W.)

The parish is dependent on springs, wells and rainwater storage. Magdalen Well, situate ½ mile N. by E. of Tetbury Church, is marked on the 6-inch map (58 S.W.) as a "Petrifying Well." It used to be a dip well, but the spring is now conveyed into a catch reservoir from which the water is piped to the Fountain near the Gas Works. The water is hard, as is the case with all the water from the Forest Marble of this district.

Cook's Pool, near Northland Cottage, ⅔ mile north-north-east of Tetbury Church.—The Forest Marble comprises beds of clay, sand and limestone, and the clay-beds hold up the water in the numerous ponds dotted about the parish, and in many cases, as in that of Cook's Pool, throw out springs which feed the ponds.

Wor Well, a spring, is situate a little under a mile to the north-east of Tetbury Church. It is readily visible from the railway, but in Aug., 1922, there was no stream flowing between it and the Station. The water is thrown out from the Forest Marble and has been tapped for the supply of Hillsome and two or three cottages.

The trough near the Three Cocks, Charlton, is supplied per pipe and tank from springs issuing from the Forest Marble in Hook's House Lane.

The wells in the parish are mostly shallow, tapping water in the Forest Marble. There are, however, several bored wells.

Boring at Upton House.—Sunk by H. J. Godwin. of Quenington, in 1913. Particulars communicated by Major Little, Upton House.

Surface-level.—About 504 ft. above O.D.

	Thickness Ft.	Depth Ft.
Well :—		
1. Subsoil and clay	5	5
2. Brown clay	1	6
Boring :—		
2a. Brown clay	19	25
3. Oolite stone	64	89
4. Blue stone	6	95
5. Oolite stone	7	102
6. Hard grey stone	7	109
7. Blue stone	7	116
8. Blue stone and clay	7	123
9. Blue stone and Lias clay	37	160

Depth from surface to rest-level of water.—116 ft. Yield.—About 18,000 gallons per 24 hrs. Water was struck at 123 ft. below surface-level and rose to 116 ft. below surface-level.

Borings at Upton Grove.—Particulars communicated by Francis N. Lloyd, Upton Grove.

No. 1 Boring.—In farmyard at the Grove. Made by J. Mullins & Sons, of Bath, in 1920. Total depth.—About 200 ft. Yield.—About 3,000 gallons per 24 hours.

This borehole was abandoned at Christmas, 1920, owing to contamination from the farmyard.

No. 2 Boring.—Cock Furlong, 250 yds. distant from boring at Upton House. Made by H. J. Godwin, of Quenington, in 1921. Total depth.—About 153 ft. Yield.—About 24,000 gallons per 24 hours.

Well at Veizey's (or Vaze's) Quarry, Chavenage Lane.[1]—In a valley immediately to the south of the causeway giving access to the quarry and a mile north-west by north of Tetbury Church.

Sunk, 1915. Ground-level.—369 ft. above O.D.

		Thickness Ft.	Depth Ft.
Soil	Reddish clayey soil, with numerous fragments of Forest Marble and Great Oolite limestone ; about ...	8	8
Great Oolite	Limestone, yellowish, oolitic. Very little water comes out of the rock, the most from a horizon about 16 ft. above the base	47[2]	55
'Passage-Beds'	Limestone, hard, bluish-grey, with conspicuous (and in places irregularly-scattered) oolite-granules ...	1	56
	Marls, grey, indurated, slightly sandy in places ; *Pseudomonotis echinata* (Sow.)	14	70
	Limestone, hard, grey, very fine-grained, slightly sandy ; occasional crinoid-ossicles : seen	2	72

This well was sunk by the Tetbury Urban District Council, but a very inadequate supply was found and the well was abandoned.

Well at 'The Folly.'—300 yds. to the south-east by south of the preceding. Depth.—80 ft. This well commences in higher beds than the preceding, but probably terminates in about the same beds.

[1] Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xix, 1915, p. 27.
[2] Of this thickness the lowest 7 ft. belongs to the 'Passage Beds.'

Thornbury—Maps : 250, 251 ; [35] ; (54 N.E., S.E., 55, 56 S.W., 63)

Thornbury is served by the West Gloucestershire Water Company : several houses have the water laid on, but otherwise it has to be fetched from standposts. The Rural District Council has three wells :—(1) Opposite the Exchange Hotel, 56 ft. deep ; (2) near London and Smith's Bank, ? 40 ft. deep, which gives a good supply ; (3) in Horeshoe Lane, about 50 ft. deep.

A good stream of water springs from Kyneton Quarry.

Thrupp—Maps : 234 ; [34] ; (49 N.E.)

The lower part of Thrupp is served by the Stroud Water Company : the remainder of the parish by wells.

Good springs thrown out by the Fullers' Earth are those below The Heavens and Lower Lypiatt ; while a good spring issues from the base of the Cotteswold Sands above the old Brimscombe Brewery.

Brimscombe is served by the Stroud Water Company. A few wells are in use. There is a good spring running to waste into the canal almost opposite the Polytechnic and there are three smaller springs, also running to waste into the canal, between the Polytechnic and Bourne Lock.

Tibberton—Maps : 216, 234 ; [43 S.E.] ; (24 N.E., S.E.)

Three large farms and five cottages have Gloucester Corporation water ; but otherwise the parish is dependent mostly on shallow wells in the Keuper.

Tidenham—Maps : 233, 250 ; [35] ; (46 S.W., S.E., 54 N.W., N.E., S.W., S.E., 62 N.E.)

Tidenham, Tutshill and Woodcroft were until about 1920, supplied by a private company, the Tidenham Water Co. This company was acquired by the Chepstow Water Co. (3, Moor Street, Chepstow) in 1920 and Sedbury and Beachley are supplied from the Chepstow Company's mains. The Tidenham Water Company's scheme was carried out by S. W. Yockney, of Wye Cottage, Chepstow, who acted as their engineer for 20 years. The following particulars of the Tidenham supply have been communicated by L. Trueman, Secretary of the Chepstow Water Company :—

Source of supply.—Strong perennial spring at the foot of Ban-y-gor Cliff.

Yield.—Winter, 1,500,000 gallons per day ; dry summer, 500,000 gallons per day. The yield was reduced to one-third of normal by the drought of 1921.

Works.—Well in River Wye bank. Water pumped by a pair of oil engines to a small tank at the top of Ban-y-gor Cliff.

Average daily quantity of water supplied.—60,000 gallons.

Quality.—Excellent, but rather hard.

Some 110 out of the 440 houses in the parish are supplied by the Chepstow Water Company : those not so supplied are dependent on wells, springs and rain-water storage.

Tirley—Maps : 216 ; [43 N.E., 44] ; (18 N.W., N.E.)

The parish is dependent on wells from 8 to 50 ft. in depth. So far, W. E. Hancock, Sanitary Inspector, Tewkesbury Rural District Council, informs me, the supply of water has been satisfactory. A well at The Haw, 150 ft. away from the Severn, he says, is affected by the rise and fall of the water in the river and the well water becomes muddy after rain.

Toddington—Maps : 217 ; [44] ; (13 N.E., S.E.)

There are a few wells in the parish (analysis, p. 277), but it is mainly supplied from Lyne's Barn (p. 98) and Stanway (p. 156).

Todenham—Maps: 217, 218; [44]; (15 N.E., S.E.)

The 78 houses in the parish are all dependent on wells. Chas. J. Gander, Sanitary Inspector, Chipping Campden Rural District Council, informs me that the wells in the village vary from 15 to 25 ft. in depth.

Tormarton—Maps: 265; [35]; (69 S.E., 70 S.W., 73 N.E., 74 N.W.)

The village is supplied by the West Gloucestershire Water Company. Houses too distant to be connected with the mains are dependent on wells and small springs.

Tortworth—Maps: 251; [35]; (56 S.W., 64 N.W.)

The parish is supplied chiefly from wells.

Brook and Crockley's farms are supplied from a spring issuing from near the junction of the Silurian and Old Red Sandstone near Howcroft Cottages.

Tortworth Court Farm is supplied from a pump over a well, about 40 ft. deep, in Silurian rocks: the farm buildings from the Bathing Pond, ¼ mile south of Tortworth Church.

Tortworth Court is supplied from a spring near the lower end of Tortworth Lake. The gardens are supplied from a spring issuing from the Old Red Sandstone on the opposite, the north, side of the road, some 175 yds. south-west of the Rectory. The water is pumped from the spring into a reservoir.

'Virgins Well' is a spring the position of which is at the letter 't' of 'Chesnut Tree' on the geological map, Sheet 35. E. A. Smith informs me that it was tested during the drought of 1921 and found to yield about 25 gallons per minute.

Tredington—Maps: 216; [44]; (19 N.W., N.E.)

The Hospital near the Tewkesbury Road is supplied from the mains of the Cheltenham Corporation Waterworks, but otherwise the parish is dependent on wells from 10 to 20 ft. deep. The supply of water, however, is unsatisfactory.

The late J. M. Collett informed me that some 10 to 12 years ago he had a well sunk at Mill Farm. At about 18 ft. down a limestone-bed 4 to 6 in. thick was broken through, after which the water rose to within 3 or 4 ft. of the surface. The water was fairly pure organically but contained about 120 grains of solids to the gallon.

Turkdean—Maps: 235; [44]; (28 S.W., 36 N.W., N.E.)

The greater part of Turkdean village is supplied with water held up or thrown out as springs by the Fullers' Earth.

The following springs are thrown out:—1.—660 yds. north-east by east of church in 'New Wood.' 2.—Good spring supplying sheep-wash, farm buildings, two cottages at Hill Barn about a mile to the east-north-east of Turkdean, and farmhouse and buildings near Church. 3.—Spring marked 'W' on six-inch map ¼ mile north-north-east of Church. Good spring, supplying cottages near by. An old pipe from it furnishes the supply marked 'Springs' (4) on 6-inch map by roadside 130 yds. to the south by west of it. 5.—Spring 294 yds. north-west by west of Church furnishes the supply for the Vicarage and for cattle. 6.—A spring close to (5) supplies Lower Dean and Castle View House. 7.—Spring by roadside opposite the School. 8.—Spring at Chalk Hill Barn. Good spring from which water is pumped to the Manor House, Turkdean. The water is very hard and has made a considerable deposit of carbonate of lime at the sheep-wash. 9.—Shewhill Barn. Good spring used for watering the cattle. 10.—Spring supplying trough on the west side of the road and a tank on the east side a little under ½ mile south-west by west of Church. All these springs ran throughout the dry period of 1921.

The well at The Manor House is about 40 ft. deep in Great Oolite. W. A. Rixon informed me that it usually had 10 to 15 ft. of water in it. At Castle Barn is a well 25 to 30 ft. deep.

Boring at Leygore Manor.—At site indicated by windmill. Made for A. E. Moss in 1912 by, and particulars communicated by, Messrs. Duke and Ockenden.

		Thickness Ft.	Depth Ft.
[Fullers' Earth Series Inferior Oolite]	1. Clay	12	12
	2. Stone	5	17
	3. Blue clay	8	25
	4. Stone	1	26
	5. Blue clay	9	35
	6. Yellow stone	1	36
	7. Blue clay	23	59
	8. Yellow stone	104	163
	9. Soft sand	3	166
	10. Stone	7	173
	11. Hard and soft sand ...	9	182
	12. Stone	43	225
	13. Red sand	14	239
[Cotteswold Sands]	14. Grey sand	15	254
[Upper Lias]	15. Blue clay	14	268

Lined with six-inch tubes to 59 ft. from the surface. Water-level.—220 ft. down. Suction-point.—250 ft. down. Yield.—Test pumping for 52 hours gave 290 gallons per hour.

A reservoir (about 15,000 gallons) is in the Manor grounds.

Twigworth—Maps: 216; [43 S.E., 44]; (25 N.E., S.E.)

The 40 houses in the parish are dependent on shallow wells.

Twyning—Maps: 216; [44]; (5 S.W., 12 N.W.)

The parish is dependent on wells from 8 to 15 ft. deep. W. J. Kerrod informs me (3rd Jan., 1922) that a well was sunk at the new Council Cottages, Twyning, is 67 ft. deep and passed through 10 to 12 ft. of sandy soil and gravel,[1] Lias limestone, 1 ft., into blue (Lias) clay. The depth of water in the well was 20 ft., but it was so saline as to be unfit for drinking purposes. Four other wells subsequently sunk at the same locality were on an average 16 ft. deep, passing through soil, 3 ft.; gravel, 1 ft.; Lias clay, 5 ft.; limestone, 1 ft.; and into clay again. They had about 11 ft. of water in them.

Twyning village is dependent on wells. Some springs issue from the sand and gravel on the north side of the village and produce a streamlet which flows through two ponds.

Chad Well is a little well, 2 ft. deep and 3 ft. in diameter, some 20 ft. from the river and a quarter of a mile south of the ferry at Twyning Fleet. Although in the alluvium it is fed with water piped from a neighbouring bank where it comes out of a gravel and sand bed resting on Lower Lias. Capt. Cope, of Abbot's Court, on whose property the well is situate, states that the water is always running. Hardness: permanent, 3·1°; temporary, 17·9°; total 21° (Clark).[2]

[1] The distribution of the sand and gravel deposits of Twyning and neighbourhood is shown on a map accompanying Miss M. E. Tomlinson's paper on the 'River Terraces of the Lower Valley of the Warwickshire Avon,' *Quart. Journ. Geol. Soc.*, vol. lxxxi, 1925, pl. x.

[2] See *Proc. Cotteswold Nat. F. C.*, vol. xxii, pt. 3 for 1926 (1927), p. 207, and pl. xxvi, fig. 1.

Well at Puckrup Farm.—1927-1928. Sunk by H. J. Godwin, Quenington; particulars communicated by T. Ward Whitfield, Trowbridge. Ht above O.D. 106 ft.

	Thickness Ft.	Depth Ft.
Soil	2	2
Sand and gravel	7	9
Marl	36½	45½
Clay	2	47½

Yield, 7,600 gallons per day (Feb., 1928). Water not very satisfactory but suitable for farm requirements only. Hardness: temporary, 19°; permanent, 13·5°; total 32·5°.

Tytherington—Maps: 250, 251; [35]; (63 N.E., S.E.)

Tytherington and Itchington are served by the West Gloucestershire Water Company, but there are some wells in use. A useful stream runs down the side of the road by the Vicarage and near where it rises is a public well belonging to the Thornbury Rural District Council.

Uckington—Maps: 216; [44]; (19 S.W., S.E., 26 N.W., N.E.)

The village, which is on a sand-bed, is served by the Cheltenham Corporation Waterworks.

Uley—Maps: 251; [35]; (48 S.E., 49 S.W., 56 N.E., 57 N.W.)

Village and parish are dependent on wells and springs. A strong spring is thrown out by the Upper Lias clay in the village near Raglan Farm. Bencombe House is supplied from a spring thrown out by the Fullers' Earth ½ mile to the south-east in Owlpen parish. Strong springs running to waste are those at Cross Banks, ½ mile south-west of St. Giles Church, Uley, and Barnwell Spring, situate about 200 yds. west of the church.

Up Hatherley—Maps: 216, 234; [44]; (26 S.W., S.E.)

This parish is on the Lower Lias. Some 20 out of 30 houses, according to the L.G.B. Return, 1915, have Cheltenham Corporation water laid on: those not so supplied are dependent on wells which are not too reliable.

Uplands—Maps: 234; [34]; (41 S.E., 49 N.E.)

See Stroud Urban District.

Upleadon—Maps: 216; [43 N.E., S.E.]; (17 N.E., S.E.)

Two farms and four cottages have Gloucester Corporation water, but otherwise the parish is dependent on wells.

Upper Slaughter—Maps: 217; [44]; (21 S.E., 28 N.E., S.E., 29 N.W.)

The village is supplied by an undertaking belonging to Col. Brassey. The source of supply is the Seven Springs, which are thrown out by the Upper Lias clay in the valley of the Windrush. The water feeds standposts in the village; but in Sept., 1922, the supply was inadequate (see Naunton, p. 123). Upper Slaughter Manor House has water from the Seven Springs supply laid on; but, in addition, has a supply available from a spring that is thrown out by the Upper Lias clay under the lawn of the house. The water from this spring is shared: half is available for the Manor House; half goes to supply Major Witts's house.

Upper Swell—Maps: 217; [44]; (21 S.E., 22 S.W.)

The village is supplied partly by the spring that supplies Abbotswood House (issuing from off the top of the Upper Lias clay some 150 yds. north-east by north of the house), and partly from a spring issuing from the same geological horizon on the Manor Farm, ⅓ mile north by east of Abbotswood House. The cottagers draw the water from a road-side dipping-place and standposts. The scheme was provided by M. Fenwick of Abbotswood House.

Moreton in Marsh obtains part of its supply at Upper Swell Mill. R. S. Arkell, of Fox Farm, informs me (3rd May, 1922) that the drinking water is got from a well, 90 ft. deep, close to the back of the house. The other supplies are rain-water tanks underground, and by pipe from the pond in the field in front of the house which is supplied by shallow surface springs which only run after heavy rainfall and issue from the bank opposite the well.

Hill Barn, the cottages near by, and troughs in certain fields are supplied with water which is raised by a windpump near Waterhead Barn to a tank at Flagstone.

Upton St. Leonards—Maps: 234; [44]; (33 N.E., S.E.)

Numerous springs are thrown out by the Upper Lias clay, including that which is the source of the River Twyver. Some issue from the Middle Lias: such a one is that at the foot of Port Way Hill which feeds the 'Red Well' opposite Knap House near the entrance to Prinknash Park. Of 391 houses in the parish 265 are supplied with Gloucester Corporation water. Those not so supplied are dependent on wells, springs, the Sud Brook, and rain-water. The supply and quality of the water in the wells varies. Wells sunk in gravel usually yield a satisfactory supply: those sunk in the Lower Lias clay, frequently a medicinal water. There is a well at Bondend some 12 ft. deep in gravel which yields a good potable supply which the villagers draw from a standpost.

The water supplying 'Red Well' is strongly chalybeate. There is a catch chamber adjoining the trough from which a pipe runs to supply a number of farms in the vicinity.[1]

A well sunk at 'Cotteswold' (between Harris Farm and the River Twyver) about 1912 is 24 ft. deep. According to Max Bellows "the supply never failed until 1921." A spring three-quarters of a mile south-west by west of Kimsbury House, between it and the road, yields a good supply. It is thrown out by the Upper Lias clay. Max Bellows informs me (15th May, 1922) that J. Fielding's house, on the site of Brimps Gardens, is supplied by a well 45 ft. deep in the bit of woodland on the slope of the hill to the north-west; also that a well sunk in 1904 at Highmeadow, Wheatridge, about 26 ft. deep, in Lower Lias Clay, yields a mineral water which is undrinkable (analsyis, p. 277) and only useful for flushing purposes.

On the east side of the main road east of Pincott, at a new house (1922), a well was sunk, and, R. C. Riches informs me, "water was obtained at 50 ft. after penetrating rock and shale." The well is in the Upper Lias.

Walton Cardiff—Maps: 216; [44]; (12 S.W.)

The village is supplied from the mains of the Cheltenham Corporation Waterworks.

Wapley-and-Codrington—Maps: 265; [35]; (69 S.W., 73 N.W., N.E.)

The parish is dependent on wells and springs. There is a deep well at Mousewell or Mowswell Farm (on the Lower Lias), and springs near by. At Cliff Farm, Wapley, there are two wells.

[1] *Proc. Cotteswold Nat. F. C.*, vol. xxi, pt. 2 for 1922 (1923), pp. 87, 88.

Well at Codrington.—A well, 70 ft. deep, in the orchard at the back of the inn passed through :—

Lower Lias...			70 ft.
Rhaetic	White Lias	Sun Bed	
		Rubbly limestones ...	
	Upper Rhaetic	Cotham Marble	
		Shales, pale ... ... yellowish-green ...	
	Lower Rhaetic	Shales, black with a bone bed	
Keuper	Upper Keuper	Tea-green Marls, arenaceous	
Carboniferous Limestone			

Water-supply good.[1]

The River Boyd in wet weather has its genesis in springs running off the Fullers' Earth in the neighbourhood of Hawkes Tyning Clump and in dry weather in springs thrown out by the Upper Lias clay to the north of Springs Farm. Locally, however, it is held to rise in the 'well' in the orchard west of Springs Farm from which a strong stream issues.

Welford-on-Avon—Maps : 200 ; [54 S.E.] ; (1 S.E., 3 N.E.)

The houses obtain their water-supply from wells. The well at The Poplars is typical. A. E. W. Paine informs me that it is 14 ft. deep in the gravel-sand deposit and yields plenty of water.

H. C. Setton informs me that his well at Willowsmede is about 40 ft. deep in Lower Lias clay with limestone-bands and that the supply is "excellent but hard." A. G. Hilder, who once resided at The Gables, states that the well formerly in use was about 12 ft. deep in sand, but that the water became badly contaminated with drainage. Mr. Hilder had a boring made in 1916, 36 ft. deep (3-in. diameter), through some gravel and sand into Lower Lias clays with limestone-bands. A good supply of water was obtained.

Westcote—Maps : 217, 235 ; [44] ; (29 S.W., S.E.)

The main supply for Westcote is a well, through the Inferior Oolite (down probably to the Upper Lias), 25 ft. deep, the water in which has not been known to fail. There is a spring on the Green, but it is not used.

A number of springs issue in the parish from the base of the Inferior Oolite.

West Dean—Maps : 233 ; [43 S.W.] ; (30 S.E., 31 N.W., S.W., 39, 47 N.W.)

While there are many wells in this extensive parish, the majority have been drained by the numerous workings for coal which have been driven through the strata in all directions. The result is that most of the houses have 'reservoirs'—the local name for rain-water storage tanks—and W. H. Davis, Surveyor and Sanitary Engineer, Coleford, tells me that all the new small houses throughout West Dean Rural District are provided with concrete tanks to catch the rain-water. The tanks are mostly of 1,500 gallons capacity.

In addition to the usual 'reservoirs' and private wells there is at Joyford a public well ; at Broadwell Lane End several deep wells, which are not used, however, until the 'reservoirs' have given out ; at Elwood, near China Engine Pit, and at Milkwall near the Steel Works, good springs running to waste ; and at Upper Lydbrook, Bourts Well, which is situate ⅔ mile S.7°E. of Upper Lydbrook Church. It is a spring issuing from the Coal Measures and has always been relied on when other wells in the neighbourhood have failed.

[1] *Quart. Journ. Geol. Soc.*, vol. lxi, 1905, p. 419.

In Hangerberry Inclosure, ½ mile south-west by south of Upper Lydbrook Church, is a spring which W. H. Davis ascertained on May 5th, 1920, to be flowing at the rate of 400 gallons per 24 hours.

Speech House Hotel and buildings are supplied from a spring issuing from the Coal Measures in the wood down the slope north of the hotel.

Borehole at Blackpool Bridge.—Sunk for the West Dean Rural District Council in 1914. Particulars communicated by Messrs. W. H. Radford and Son, Nottingham. Surface-level, 231 ft. above O.D.

Borehole (6-in diameter) :—		Thickness Ft.	Depth Ft.
	1. Top soil	1½	1½
	2. Gravel and stone	3	4½
Old Red Sandstone	3. Red shale	3½	8
	4. Red sandstone	22	30
	5. Red shale	5½	35½
	6. Red clay	3½	39
	7. Red sandstone	2½	41½
	8. Very hard red sandstone... ...	2½	44
	9. Red sandstone	96	140

Water-level.—226 ft. above O.D. or 5 ft. below surface-level. Yield.—Messrs. Radford and Son inform me (5th Oct., 1921) that the yield was tested up to 43,000 gallons per day.

Westerleigh—Maps: 251, 264, 265; [35]; (68 S.E., 69 S.W., 72 N.E., 73 N.W.)

Some 184 out of 258 houses in the parish are supplied by the West Gloucestershire Water Company. The remaining houses have wells with a poor and insufficient supply.

Westerleigh Boring.—Boring for coal 600 yds. S.W. of Stanshawe's Farm 1½ miles N.E. of St. James's Church, Westerleigh. Six-inch map Gloucestershire 69 S.W. One-inch geological map (Old Series) 35. Communicated by Mr. R. M. Dillwyn, of Bridgend, Glamorgan, March, 1918. Boring commenced March, 1912, finished December, 1912.

An abstract section has been made by T. C. Cantrill and B. Smith. The following particulars are all that is necessary to give here :—

	Thickness Ft.	In.
Soil	1	0
Keuper Marl (?)	10	0
Coal Measures	1,420	7

The Coal Measures include Pennant Series and Lower Coal Series; the thickness of the former is uncertain but may be either 420 ft. 7 in. or 661 ft. 6 in.

Frog Lane Pit, Coalpit Heath.—The section in this pit has been described by H. B. Woodward.[1]

West Littleton—Maps: 265; [35]; (73 N.E., S.E.)

The village is supplied by wells.

Westonbirt-with-Lasborough—Maps: 251; [34, 35]; (57 S.W., S.E., 65 N.W., N.E., S.E.)

Water is laid on to Westonbirt House (now a girls' school) and the houses on the estate and the fields from a private undertaking. The source of supply is a well in the Westonbirt Estate Yard (see p. 169), for particulars of which I am indebted to the late Sir George Holford.

[1] 'Geology of East Somerset and the Bristol Coal-Fields' (*Mem. Geol. Surv.*), 1876, p. 37.

Lasborough Park is supplied from a spring 150 yds. north by east of St. Mary's Church, the water from which gravitates to a large tank in the roof of Lasborough House. A branch line supplies Lasborough Farm and buildings.

Springs thrown out by the Fullers' Earth 300 yds. west-south-west of the House are collected in reservoirs and forced by four rams and a waterwheel along a 2-in. main through the Long Covert, across the Bath Road, to supply Bowldown Farm and the water-troughs. A branch line from the main supplies Lasborough Cottages.

Well in the Westonbirt Estate Yard.—Sunk in 1864 by R. S. Holford. Surface-level 395·77 ft. above O.D.

Through Forest Marble into Great Oolite. ... ... 137 ft.

Heading level at 129 ft. Boring (diameter 4 in.) :—Total depth (from bottom of well) 36 ft. Water-level.—When pumps have stopped for 1 hour, 61 ft. ex surface. Dry summer of 1911, 92 ft. ex surface.

This well has never contained less than 40 ft. of water, even when supplying 30,000 to 40,000 gallons a day to the neighbourhood.

Boring at Leighterton Aerodrome (demolished).—In Westonbirt-with-Lasborough parish, a mile north-by-east of Leighterton Church.

Particulars communicated by Henry Marten. Shot boring commenced 31st Dec., 1918 ; finished 12th Oct., 1918. Surface-level 626 ft. above O.D.

Shaft.—10 ft. deep and 4 ft. square. Boring.—326 ft. ; total depth, 336 ft.

		Thickness Ft.	Depth Ft.
Forest Marble	Soil and shattered rock	4	4
	[" Forest Marble "]	6	10
	Boring [? Clay]	2	12
Great Oolite	Very hard rock at about 30 ft. down ... Blue clay, 6 in. thick at about 101 ft. 6 in. ... ... Hard blue rock, 6 ft. thick, from 102 to 108 ft. ... ... Hard blue marl, 2 ft. thick, from 108 to 110 ft. ... ... Hard blue rock at 120 ft. ... ... Hard blue rock at 128 ft. ... ... Very close-grained rock at 135 ft. ...	133	145
Fullers' Earth	Hard blue marl struck at 145 ft. down Hard blue marl and seams of hard blue rock and blue clay at 164 ft. ...	70	215
Inferior Oolite [and Cephalopod Bed]	Light blue stone struck at 215 ft. down Very hard rock at 250 ft. ... ... Clay, 2 ft. thick, from 303 to 305 ft. ... Very hard rock encountered at 308 ft. Pecten Bed (see p. 150)	101	316
Upper Lias	[Sands : penetrated]	20	336

Water lost in borehole at 92 ft.

Rest-level of water on 28th Feb., 1918—100 ft. below surface.
,, ,, ,, 13th March, 1918—108 ft. ,,
,, ,, ,; 13th April, 1918—303 ft. ,,
,, ,, ,, 21st June, 1918—287 ft. ,,

Water lost in borehole at 290 ft. Core tube broke off at the bottom of the borehole at 308 ft. At one time during the sinking, Mr. Marten informs me, the water ran over at the top of the borehole.

Weston-on-Avon—Maps : 200 ; [54 S.E.] ; (1 S.E., 2 S.W., 3 N.E., 4 N.W.)

The little village has water piped to it from a spring to a tank in its centre, from which the water is obtained by a pump. Two wells only (about 20 ft. deep), are in use in the village.

Weston Subedge—Maps : 200, 217 ; [44, 54 S.E.] ; (7 N.E., S.E.)

Weston Subedge village is on Lower Lias clay and is supplied by an undertaking of the Pebworth R.D.C. The source of supply is the Newcombe Spring (analysis, p. 277) which is thrown out by the Upper Lias clay in The Rookery, Newcombe, $1\frac{1}{6}$ miles south by west of Weston-Subedge Church, 400 ft. above the village. The water is conveyed to a storage reservoir (capacity—15,000 galls.) $\frac{1}{2}$ mile south by west of the Church, whence it is piped to stand-pipes and houses in the village. The temporary hardness of the water is 13·9°, the permanent, 3·6°. Norton Hall is situate in a detached portion of the parish. Particulars of some wells here have been given by Prof. W. F. Barrett[1] in connection with his investigation into the "so-called" Divining Rod.—"An old well in the house yard 25 ft. deep, and 11 ft. 9 in. to the water ; supply insufficient. . . ." "Mullin's [the Dowser's] well in the stable yard, 28 ft. 6 in. deep, and 8 ft. 9 in. to the water." "Mullin's well, 'close to the house,' . . . 17 ft. deep, and 11 ft. 8 in. to the water."

Whaddon—Maps : 234 ; [43 S.E., 44] ; (33 S.W., S.E.)

Village and parish are dependent on wells. On Whaddon Green is a village pump. The well from which the water is drawn was originally 30 ft. deep and yielded water of good quality. Subsequently it was deepened in the hope of adding to the supply, but the water obtained was brackish. A well in Lower Lias clay, situate some 75 yds. west by south of the Church supplies five cottages. Col. E. B. Jeune informs me that Whaddon Manor is supplied from a well 31 ft. deep through :—

		Thickness Ft.
	Yellow clay	9
	Gravel	$1\frac{1}{2}$
Lower Lias	Blue clay	$20\frac{1}{2}$

William Bellows informs me that the well at Tuffley Lawn (6-inch map, 43 N.E.) is $4\frac{1}{2}$ ft. deep in Lower Lias clay, and that it yields an unfailing supply of good water.

Wheatenhurst—Maps : 234 ; [43 S.E.] ; (40 N.E., S.E.)

The parish is on Lower Lias clay and is supplied by wells from 20 to 40 ft. deep, and rainwater.

The well at Parklands Farm, Whitminster, is 30 to 40 ft. deep in Lower Lias clay. The water is hard but there is a plentiful supply.

The well at Whitminster House is 31 ft. 6 in. deep in Lower Lias clay. On 29th May, 1922, the depth of water in the well was 19 ft. 6 in. The water is hard and the supply good.

Whiteshill—Maps : 234 ; [34, 35, 44] ; (41 S.E.)

A portion of the parish is served by the Stroud Water Company, but there are many wells in use and springs thrown out by the Upper Lias clay. The depths of the wells vary according to their situation.

There are three useful springs in Ruscombe, namely :—(1) Near the Chapel ; (2) near the B.M. 475·4 at the sharp bend of the road north of Ludlow Green ; (3) the 'Double Spout', near the B.M. 413·6 in the dip

[1] *Proc. Soc. Psychical Res.*, vol. xv, 1900, p. 327.

between Ludlow Green and Primrose Hill, which yields more water than any other in the neighbourhood and is the source of the Ruscombe Brook.

Whittington—Maps: 217, 235; [44]; (27 N.W., S.W., S.E.)

The western part of Whittington village has a piped supply to taps from a spring thrown out by the Upper Lias clay in the field called "Pateley," near Whalley Farm: the eastern part, a piped supply from a spring in the field called 'Lower Court Field'—the pipe discharging into a trough.

The fine Syreford Springs (analysis, p. 278) are thrown out by the Upper Lias clay, and issue from the base of somewhat slipped Inferior Oolite, at about 564 ft. above O.D. A ram at the spring-head supplies the Bungalow; cottagers living beyond the road obtain their water from a dip at a spring.

The water from the Syreford Springs has been impounded to form a mill-pond. Various estimates have been published as to the yield of these springs, for example:—

Yield per 24 hours.	Authority.
About 3,000,000 to 4,000,000 ...	Wm. Pole, *Rep. Royal Comm. Water Supply*, 1869, Appendix O, p. 67.
Often yields 4,000,000	R. Etheridge, *Proc. Cotteswold Nat. F.C.*, vol. xi, p. 56.
About 5,000,000	H. B. Woodward, 'Jurassic Rocks of Britain,' vol. iv (*Mem. Geol. Surv.*), 1894, p. 504.

Wick-and-Abson—Maps: 265; [35]; (72 S.E., 73 S.W., 76 N.E., 77 N.W.)

Parts of Wick contiguous to the road to Doynton are served by the West Gloucestershire Water Company: the houses not so supplied are dependent on wells.

Wickwar—Maps: 251; [35]; (63 S.E., 64 N.W., S.W.)

Wickwar is supplied by the West Gloucestershire Water Company. Houses not so supplied are dependent on wells.

Boring at Wickwar Brewery.—(Messrs. Arnold Perrett and Co., Ltd.).

Site.—Outside, but close to, the brewery in the old quarry close to the Midland Railway, which was partly utilized in making the brewery cellarage. Surface-level.—About 170 ft. above O.D. Year when sunk.—1894-95. Depth of boring.—Dug well, 3 ft. 6 in., boring 359 ft. 6 in.—total 363 ft. Diameter, 7¼ in. Rocks penetrated:—

	Thickness Ft.	Depth Ft.
Dug well	3½	3½
Boring:—		
Red marl	18½	22
Red sandy marl	5	27
Red marl	31	58
Dark grey sandstone	3½	61½
Red marl	16	77½
Red and blue marl	14	91½
Red marl	54	145½
Hard rock	3½	149
Grey sandstone	10	159
Red marl	21½	180½
Hard rock	1	181½
Red marl with white spar	8½	190
Red marl	10	200

	Thickness Ft.	Depth Ft.
Red marl with white spar	1½	201½
Blue rock with white spar	16	217½
Green sandstone	21½	239
Red marl	4½	243½
Red marl with white spar	31½	275
Red marl with thin beds of sandstone ...	30	305
Grey sandstone	1½	306½
Beds of rock and blue marl	16	322½
Grey sandstone and blue shale	3	325½
Limestone	19	344½
Blue shale and sandstone	3½	348
Limestone	8	356
Blue shale	1	357
Limestone	6	363

Yield and Quality.—The water obtained was small in quantity, at 150 ft. about 10 barrels per hour: at 363 ft., 300 gallons an hour, and after a shot had been fired at that depth, 500 gallons per hour. It was unsatisfactory in quality, the predominant salts being alkaline carbonates and sulphates with chloride of sodium, as the following analysis shows :—

Water from 150 ft. down in boring at Wickwar Brewery: 1895.

	Grains per gallon
Sodium chloride	28·99
,, sulphate	14·87
Calcium carbonate	6·12
Magnesium ,, ...	4·45
Sodium ,, ...	20·03

Arnold Halsey, Managing Director, informs me (15th Dec., 1921) that this water is not used for brewing purposes. He adds: "Our supply of brewing water is obtained from a well driven in the limestone, the supply from which is copious and of excellent quality."

Boring at the High Street Brewery.—(Messrs. J. Arnold and Sons).

This brewery is now closed. The following are particulars of a boring here, which have been supplied by J. H. Arnold, of Wickwar.

Site.—Brewery premises. Year when sunk.—About 1890. Depth of boring.—120 ft.: diameter, about 6 in. Rocks penetrated.—Old Red Sandstone. Yield.—Say 600 gallons per hour.

This source of supply is not now used for any purpose.

Willersey—Maps: 200, 217; [44]; (7 N.W., S.W.)

The village is supplied by an undertaking of the Pebworth R.D.C. The source of supply is a spring issuing from at, or near the base of the Sandy Beds of the Middle Lias some 750 yds. S.E. of the Church. The water is conveyed in glazed pipes to a covered reservoir (15,000 gallons), whence it supplies the village through iron pipes. There is no filtration; the water has no plumbo-solvent action; temporary hardness, 31·4°, permanent 3·6°; and it is pure and sufficient.

At one time two springs contributed to the supply, but several complaints were made concerning the discoloured nature of the water. Dr. D. Gordon Evans, M.O.H., made a chemical analysis of the water and found that it contained iron in solution. On opening up to the source of the springs, which flow into the covered reservoir supplying the village, two springs from different sources were found joining each other. He then made a further chemical analysis of each spring separately, and found that one of them did not contain iron in solution, although the other did. The spring containing the iron in solution is now disconnected altogether, and is drained away.

The remaining spring, which is free from all impurities, is an ample source for supplying this village.[1]

Winchcomb—Maps: 217; [44]; (13 S.W., S.E., 20 N.W., S.W., N.E., S.E.)

Since 1887 Winchcomb has been supplied with water from St. Kenelm's Well, a spring covered by a stone well-house,[2] 1¼ miles east by south of Winchcomb Church, and Park Cottages Spring, about 1¾ miles south-east by east of the Church. Both springs are thrown out by the Upper Lias clay.

The main supply from St. Kenelm's Well is piped to the Winchcomb reservoir lower down the hillside about ½ mile to the west by north, but some is forced up to Little Farmcote (or Farmcote Wood). The remainder of the supply to Winchcomb is obtained from the Parks Cottages Spring, the water from which is piped *via* Sudeley Lodge into the Winchcomb reservoir.

The St. Kenelm's Well supply was presented to the town by Mr. Dent Brocklehurst and Mrs. Dent. Mr. Brocklehurst had works carried out whereby 10,000 gallons per day were conveyed from the Park Cottages' Spring direct into the Winchcomb reservoir to supplement the supply from St. Kenelm's Well. The pipes were such as to allow of an additional supply of 10,000 gallons a day to be delivered if required and conditional upon it being available after Sudeley Castle and estate had taken what they required. Usually it has been available and at the present time Winchcomb is said to receive the 20,000 gallons a day from this source.

The Winchcomb Baths are supplied by the Babesmore.

St. Margaret's Spring is a spring issuing from the Sandy Beds of the Middle Lias in a valley in the hillside between Winchcomb and Gretton. The yield of this spring varies: at the end of July, 1921, it was given as 1,964 gallons per day, but on 15th July, 1922, it was not less than 3,000 gallons per day.

Wells at Gretton.—Previous to 1893 the village was dependent on wells. Almost every house had one, but now few are in use, the majority having been either filled up or covered over. As will be seen from the following particulars obtained during the dry summer of 1921, all had water in them. The water in the well at the Post Office is saline and is only used for the cattle, which are very fond of it.

Position of Well	Total depth in feet	Depth to water in feet	Remarks
1.—In garden immediately south of the War Memorial	9	7	In Lower Lias immediately below junction with Middle Lias.
2.—At the Post Office ...	24	10	Lower Lias. Saline.
3.—Tithe Farm, in "Home Field" close to road	9	7	In Lower Lias immediately below junction with Middle Lias.
4.—Duglynch Lane (Mr. Power's cottage)	17	7	Do. do.
5.—Church Cottage, near the Church	16	9	Lower Lias.
6.—Tither Farm, "Lower Yard," near gate on north side of road opposite school	10	7	Do.
7.—Near the old Church	13	7	Do.
8.—Myrtle Cottage ...	13	6½	Do.

[1] 'Ann. Rep. for the year 1906 on the Pebworth Rural District . . . . .' Evesham, 1907.

[2] See Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xxiii, pt. 1 for 1927, p. 8; and *Trans. Worcestershire Nat. C.*, vol. viii, pt. 3 for 1925 (1927), p. 139.

The public supply was provided in 1893 and is obtained from a spring that issues from the Sandy Beds of the Middle Lias at the north-east corner of Gretton Wood on the side of Gretton Hill. The water is collected into a reservoir from which it gravitates to standposts in the village. Littleworth and Greet are supplied from this source.

Windrush—Maps: 235; [44]; (37 S.W., 45 N.W.)

The village obtains water from the "Windrush Mill Supply." The spring-head is at the pump-house (marked on the 6-inch map, 37 S.W.), ¼ mile west-north-west of the Church, and is thrown out by the Upper Lias clay. The water from the spring, E. G. Hampshire informs me, supplies the following places:—"Windrush Mill House, Manor, Church and Glebe Farms, Windrush; part of Windrush Village, Camp Farm, Sherborne Park Farm, Ladbarrow Farm, part of Aldsworth village (see p. 46), Wall Farm, Aldsworth, Blackpits Farm, and Woeful Lake New Cottages. This supply and fittings are the property of Lord Sherborne and waters a very large area embracing nearly the whole of the village of Windrush and Aldsworth, nearly all the cottages in which, belonging to Lord Sherborne, have the water laid on inside the houses. There are two storage reservoirs on this supply, one at Camp Farm, near Windrush Camp (589 ft. above O.D.), holding 36,000 gallons; and one above Hill Barn in Sherborne parish (596 ft. above O.D.), holding 15,000 gallons.

"The flow of the spring furnishing the supply is between 15,000 and 20,000 gallons per 24 hours."

Rangehill Copse Spring about ¾ mile south from Windrush village is thrown out by a marly bed in the White Limestone division of the Great Oolite.

Winson—Maps: 235; [34, 44]; (44 N.W., S.W.)

Winson village is situate on the basement beds of the Great Oolite just above the Fullers' Earth.

Welling up in the bottom of a pond in the village is a very powerful spring, the Winson Spring, said to be equal in yield to the Bibury Spring. It is thrown out by the Fullers' Earth.

The village is supplied from the Winson Spring, the water of which is pumped to a cement reservoir (20,000 gallons) a little over ⅔ mile to the south-west by Fosse Cross Lane to Barnsley Wold, from which the water gravitates back to Winson, and also to Arlington. Potato Barn, on Barnsley Wold, is also supplied from this tank. There are two other springs in Winson.

Montreal Barn and House, on the Forest Marble, are supplied by wells from 15 to 20 ft. deep.

Winstone—Maps: 234, 235; [44]; (42 N.E., S.E., 43 N.W.)

Nearly all the villagers of Winstone obtain their water from a spring, thrown out by the Fullers' Earth, in the village which is caught in an underground tank. The spring was enfeebled in the drought of 1921. The Rectory has a shallow well, which always yields sufficient water and the surplus goes to Manor and Croft Farms. At the Manor Farm is a well 20 ft. deep and 3 ft. in diameter, the water from which is pumped to an underground tank (about 2,000 gallons), whence it gravitates to the farm, to taps and troughs. There is a good spring between the farm and the Church, and several, which, however, ceased to flow in the drought of 1921, below the Church.

The well at Gaskill's Farm gave out in 1921. Water is pumped from it to a tank in the roof of the house. There is a good spring, thrown out by the Fullers' Earth, between here and Syde, which is not much used.

A well near Beech Pike, in Great Oolite, is about 70 ft. deep, and gives a good supply. See also Elkstone, p. 91.

Winterbourne—Maps: 250, 264, 265; [35]; (68 N.W., S.W., S.E., 72 N.W., N.E.)

Winterbourne is served by the West Gloucestershire Water Company. Houses not so supplied are dependent on wells and springs.

A trial boring for coal at Winterbourne has been described by T. C. Cantrill and B. Smith.[1]

Withington—Maps: 235; [44]; (27 S.W., S.E., 35 N.W., S.W., N.E., S.E.)

The greater part of Upper Withington is supplied with spring water, pumped from the spring known as 'The Tunnel' to a reservoir near the B.M. 583·6, about ¼ mile south-west by west of the church. The lower part of the village from Harnham End to the Corn Mill in Lower Withington obtains its water from the River Coln, several intakes being in the mill-race.

The following places are supplied with spring water thrown out by the Upper Lias clay:—Elwell, Thorndale, Foxcote and Foxcote House. The following are supplied by spring water thrown out by Fullers' Earth:—Ravenswell, Jerusalem, Shornhill, Hilcot Wood, and Pegglesworth Hill.

Some good springs issue at Woodbridge ('Woodside' on the geological map, Sheet 44) and run to waste into the Coln.

Woodchester—Maps: 234, 251; [34, 35]; (49 N.W., S.W., N.E., S.E.)

Woodchester is 'mained' by the Stroud Water Co. and most of the large houses are connected therewith; but many of the cottagers draw their water from 'spout springs,' in particular the 'Ram Pitch Spring,' near the Ram Inn, and 'Turner's Spring' at the top of Frogmarsh Lane.

Woodmancote—Maps: 217; [44]; (19 N.E., S.E., 20 N.W., S.W.)

The two principal springs, for there are many small ones, thrown out by the Upper Lias clay, are the (*a*) Wickfields, and (*b*) Bushcomb Wood Springs. The former is the main source of supply of Bishops Cleeve (p. 56), but supplies also part of Woodmancote. G. H. Phillott informs me that it yields 6,170 gallons a day. The Bushcomb Wood Spring issues in a field on the south side of the wood, which is on the western slope of Nottingham Hill, and according to G. H. Phillott its yield is 3,320 gallons a day. It supplies some sixteen houses (mostly in the parish of Woodmancote) in Bushcomb Lane.

Springs issuing from at or near the base of the Sandy Beds of the Middle Lias in the grounds of Mount Vernon, below Holder's Hill, and from a higher horizon by the side of Woodmancote Lane, participate in the supply to Bishop's Cleeve (p. 56).

Cleeve Hill Hamlet.—The hamlet derives its water-supply from wells and springs. One of the best supplies is at Malvern View Hotel where there is a well 33 ft. deep with a heading 11 ft. long driven hillwards and worked with a wind-pump. The well at the Golf House is about 40 ft. deep and reached Upper Lias clay in which were limestone-masses.

A spring rising in Thrift Wood supplies, by pipe, all but about two of the houses situate by the main road and in Southam parish (p. 153). 'Greystones' is supplied, per Miss Beale's pipes, from this source.

The Stockwell Green Spring (analysis, p. 278), which is at present running to waste, was tapped by a trial well sunk in 1910 on The Green for a public supply, but subsequently abandoned. The Emblem Cottage pipe, fed by the same spring as that tapped in Stockwell Green well, in February, 1909, yielded 2,448 gallons per day. Dick's Spring (analysis, p. 278), situate between Post Office Lane and Stockwell Green, which now supplies 22 houses, on November 6th, 1911, was flowing at the rate of 1,728 gallons per day.

[1] On a boring for Coal at Winterbourne, Gloucestershire, 'Summary of Progress' for 1918 (*Mem. Geol. Surv.*), 1919, pp. 53-57.

The spring on the cart-road to the south-east of the 'Rising Sun,' about 100 yds. or so from the hotel, gauged in February, 1909, was running at the rate of 1,728 gallons per day.

Woolaston—Maps: 233, 250; [35]; (46 S.E., 47 S.W., 54 N.E., 55 N.W.)

A public supply for the parish of Woolaston has been provided by the Lydney Rural District Council. The source of supply is a strong spring issuing from the upper beds of the Old Red Sandstone at the head of the valley in Woolaston Common. There are two reservoirs (combined capacity 17,000 gallons) at the spring-head, from which the water gravitates to numerous standposts in the more populous parts of the parish and is laid on to a few houses. There are a few wells at various houses in use. There is a public well on Woolaston Common.

High Woolaston is on Old Red Sandstone and is supplied by wells in the gardens of the houses; a public tap, fed from the Woolaston Common reservoir; while High Woolaston Farm has water from a stream, coming from a spring in the wood forced to it by a ram.

There is a public pump near Park Hill Chapel which raises water from a tank that catches a spring issuing from the Old Red Sandstone.

The water from Ashwell under Ashwell Grove is piped to a reservoir (40,000 gallons) on Ashwell Grounds, which supplies Ashwell Farm and Sedbury Park.

Woolstone—Maps: 216, 217; [44]; (19 N.E., 20 N.W.)

The village is supplied by wells. There are about four wells with pumps at private houses on the south slope of Crane Hill, but quite half the village obtains its water from a well 15 ft. deep which yields an unfailing supply of good, but strongly chalybeate, water.

Thomas Williamson informs me that, anxious to obtain a larger supply of water for the Grange, cottages and farm, he bored (in the spring of 1907) to a depth of 90 ft. (diameter 4 or 5 in.) in the orchard 170 yds. north-west by west of Woolstone Church. The site of the borehole is on the line of the north-and-south fault west of the church and the deposit penetrated is blue Lias clay. No water was found. Mr. Williamson also sunk a well, 25 ft. deep, 400 yds. north of Woolstone Church and about 30 yds. north of the south-eastern corner of the field called 'Upper Lifts,' but was unsuccessful again. "We went through a good deal of rock and rough ragstone of the Oolite formation similar to that on the top of Crane Hill. At the bottom of this well we got into a good deal of sulphide of iron and after careful tests we were satisfied that it was this mineral that had acted strongly on the divining-rod, and which we mistook for a strong spring of water" (T. W., 7th Jan., 1922).

Wormington—Maps: 217; [44]; (13 N.E.)

Village and parish are dependent on wells, the water in which is stated to be adequate in quantity and satisfactory as regards quality.

C. Gardner, Surveyor, Winchcomb R.D.C., informs me that when a sewer was laid through the village some years ago a quantity of water was found about 3 ft. 6 in. down.

Wotton St. Mary Without—Maps: 216, 234; [44]; (25 N.E., S.E.)

Out of 391 houses 265 are supplied with Gloucester Corporation water: those not so supplied are dependent on wells, mostly shallow, sunk into gravel.

Wotton-under-Edge—Maps: 251; [35]; (56 N.E., S.E., 57 N.W., S.W., 64 N.E.)

The public supply of Wotton-under-Edge (Dursley R.D.C.) is derived from two sources:—(1) from springs thrown out by the Fullers' Earth

(between the 600- and 700-ft. contour lines) at Hamlin Brake, $1\frac{5}{8}$ miles north-east of St. Mary's Church, Wotton-under-Edge ; and (2) from springs issuing from the base of the Cotteswold Sands above Coombe in Tyley Bottom—$\frac{7}{12}$ mile above the old Coombe Valley Brewery.

No. 1 was the original supply (carried out about 30 years ago by A. P. I. Cotterell) and the water gravitates to a service reservoir (99,000 gallons) in the quarry by the side of the Wotton-Symonds Hall Hill road north of Combe. The water from No. 2 is obtained by headings driven into the hill side connected with a 350,000 gallon ferro-concrete sump.

The Ridge is supplied from a strong spring thrown out by the Fullers' Earth some 300 yds. north-east by north of the house, from which the water is pumped. Ridge Farm is supplied by a very small spring, thrown out by the Fullers' Earth to the south-east of the farm. Symonds Hall Farm is supplied by a spring, thrown out by the Fullers' Earth, near the quarry south-east by east of the farm.

Warren House has water laid on from the Wotton-under-Edge supply.

Wotton Vill—Maps : 234 ; [44] ; (25 S.E.)

Five houses have Gloucester Corporation water laid on.

Wyck Rissington—Maps : 217 ; [44] ; (29 N.W., S.W.)

The village is supplied by a private undertaking.[1] Spring water is pumped by a wind-pump at Holly Hill to a reservoir above Wyck Hill House, from which it gravitates to the mansion (per a 2-in. pipe) and village. Springs issue (? from at or near the base of the Sandy Beds of the Middle Lias) in the covert below Wyck Hill House. The water is caught in a sump and pumped by rams to the reservoir referred to above. The Fountain is supplied from this source ; but as when the springs run low, water fails at The Fountain, a tap to a connection with the Holly Hill supply was attached.

The water for farm-purposes at Heath Hill (Ethel) Farm is obtained from the Dikler at Stow Bridge (on the Bourton-Stow road), from which it is pumped : that for potable purposes from wells " through loam into [Lower Lias] clay."

Yanworth—Maps : 235 ; [44] ; (35 N.E., S.E., 36 N.W., S.W.)

Yanworth village is for the most part on the basement beds of the Great Oolite and is supplied by wells in the street and gardens, but several ran dry in 1921. That at the School held out. The Laurels is supplied from a spring to the south. Normally its yield, E. G. Hampshire informs me, is 8,000 to 9,000 gallons per day. A spring half-way between The Laurels and the church supplies, by gravitation, the Church Farm and cottages. Another spring between this last and that supplying The Laurels, Mr. Hampshire informs me, yields on an average 5,000 gallons per 24 hours, but it has recently (1921) been found, by analysis, unfit for domestic purposes.

The spring in Oaks Bottom, which is piped to the reservoir for Stowell House, yields, according to Mr. Hampshire, 10,000 gallons per 24 hours in normal times : the three a little to the east, about 60,000 gallons, and their waters flow to waste.

Yate—Maps : 251, 265 ; [35] ; (64 S.W., 69 N.W., S.W.)

Some parts of Yate are supplied by the West Gloucestershire Water Company : parts not so supplied are dependent on wells.

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[1] See also L.G.B. Return, 1915, p. 270.

Boring at Yate.[1]—Site.—In field on north side of the Bristol road 400 yds. west of Yate Station. Surface-level.—225 ft. above O.D. Made for R. M. Dillwyn, of Bridgend, with a view to testing the character of the Lower Coal series present in the eastern limb of the synclinal fold that forms the northern point of the Bristol coalfield, by Messrs. Vivian's Boring and Exploration Company, Ltd. Boring was begun in Aug., 1918, and completed in July, 1920. The dips appeared to range between 10° and 35°.

An abstract section of the borehole has been published by J. Pringle. The following particulars are all that are necessary to give here :—

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Soil and rubble	2	9	2	9
Coal Measures :—				
Pennant Series	1,056	1	1,058	10
Lower Coal Series	1,144	6	2,203	4

Boring (No. 2) for Coal about 750 yds. W. of Stanshawe's Court, ¾ mile S.W. of Yate. Six-inch map, Gloucestershire 69 S.W. One-inch geological map (Old Series) 35. Communicated by R. M. Dillwyn, of Bridgend. Glamorgan, March, 1918. Date of sinking, 1913. Commenced rotary boring at 52 ft. 8 in. Height above O.D., ? about 250 ft.

An abstract section has been made by T. C. Cantrill and B. Smith. The following particulars are all that it is necessary to give here :—

	Thickness Ft.
Soil	2
Keuper Marl (?)	7
Coal Measures	704

[1] Pringle, J., 'On a Boring for Coal at Yate, Gloucestershire,' 'Summary of Progress' for 1920 (*Mem. Geol. Surv.*), 1921, pp. 92-95.

III.—URBAN DISTRICT SUPPLIES

Awre—Maps: 233, 234; [35, 43 S.E.]; (39 N.E., S.E., 40 N.W., S.W.)

The villages of Awre, Hamstalls, Northington, Hall Farm and Poulton Court are on the Lower Lias and are dependent on wells, not above 25 ft. in depth. There is a pump in Awre village belonging to the Council which supplies five houses. H. E. W. Hook informs me that the water from a well at White's Court Cottage "smelt and tasted of sulphuretted hydrogen."

Wells in the Old Red Sandstone along Hagloe ridge, at Etloe, Oatfield, Viney, Nibley Hill, Kingsland, Underdean, Oaklands (or Cox Farm), Oaklands Park and New House range from 20 to 50 ft. in depth. They yield a constant supply of good water. According to Mr. Hook there are two wells—the deepest in the district—at Oaklands (or Cox Farm), and Blakeney and Nibley Green are supplied by wells from 10 to 20 ft. deep in the Old Red Sandstone, and no complaints of shortage have been received. There is a pump in Blakeney, belonging to the Council, which supplies about twenty houses.

About three families at New Green obtain their water from a standpost belonging to the East Dean Rural District Council. Brains Green is dependent on wells, about 40 ft. deep, and springs situate in East Dean and in the valley which runs from Soudley to Blakeney.

In addition to the springs referred to above there are several smaller ones in the valley between Soudley and Blakeney. Springs, collected into a reservoir, supply Hawfield: a spring supplies two houses on the south side of Blakeney; and another, three houses at Gatcombe. All these springs issue from the Old Red Sandstone and are constant.

Charlton Kings[1]—Maps: 217, 235; [44]; (26 N.E., S.E., 27 N.W., S.W., 35 N.W.)

Some 960 houses out of 1,094 have Cheltenham Corporation water laid on. Houses not so supplied, mostly in the outlying portions of the Urban District, are dependent on wells and springs. The wells in the superficial sand-bed are, as a rule, not more than 20 ft. deep. There are, however, deeper wells at:—

The Diamond Sanitary Laundry.—Depth.—31 ft. 6 in., in sand, the bottom portion of which is "of a sandy clay nature." Diameter.—3 ft. 6 in. Depth of water.—This has not been less than 11 ft. 9 in.

F. A. Middleton, Sanitary Inspector, informs me that the daily average quantity of water drawn is 25,000 gallons.

Bafford House.—Depth.—50 ft., in sand "running at the bottom."

This well is not now in use as the house has Cheltenham Corporation water laid on.

Springs.—A spring issues from the junction of the superficial sand-bed and Lower Lias clay in Spring Bottom, but is not used for potable purposes.

A few insignificant springs issue from at or near the junction of the Sandy Beds of the Middle Lias with the Lower Lias. Water issues from this horizon in Timbercombe.

Numerous springs, thrown out by the Upper Lias clay, occur high up on the hill-sides. Where stretches of hill-side gravel occur, however, the water issuing from this horizon does not show itself until the lower limits of those gravel-patches have been reached. Springs occur (1) near Northfield, some

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[1] Wright, Dr. T. and D. J. Humphris.—Report on the Sources of an Additional Supply of Water to the Town of Cheltenham, 1863. L. Richardson, *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 3, 1912, pp. 297-310. (Accompanied by the six-inch map, 26 N.E., geologically coloured.) *Ibid.*, vol. xviii, 1913, pt. 2, pp. 125-136. (Accompanied by the six-inch map, 26 S.E., geologically coloured).

of which constitute part of the supply of the Hewlett's Reservoir (Cheltenham Waterworks); (2) forming the headwaters of the Ham Brook; (3) near Coldgate; (4) in the valley between Wistley Hill and Charlton Kings Common constituting the headwaters of Lilley Brook. The spring to the south of Vineyards Farm yields about 2,000 gallons a day; (5) draining Charlton Kings Common and forming the headwaters of Southfield Brook which flows into Lilley Brook. A strong spring comes out of the hill-side gravel ⅓ mile south by east of Southfield Farm (42 on map, pl. xvi, *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2); a spring situate ½ mile south by west of Lilley Brook Hotel (40 on map) feeds a reservoir (41 on map) which supplies the Hotel and, in part, Southfield Farm. At the end of a long dry summer this spring yielded 2,000 gallons a day.

The collecting grounds for the headwaters of the five tributaries of the Chelt in this district are not great, the prevalent dip of the rocks is south-easterly, and therefore the majority of the springs decrease greatly in yield in periods of drought. On the other hand, in wet periods, the streams become greatly augmented by surface-drainage, the 'sand-bed' soon absorbs water, and the Chelt becomes 'in flood.'

Cirencester[1]—Maps: 235, 252; [34]; (50 N.E., S.E., 51)

The old portion of the town, the Roman Corinium, is situate on a gravel-bed (anything up to 25 ft. in thickness) alongside the Churn. Allen Harker stated that excavations showed that the Roman houses and walls were built upon it. Much of the gravel has been dug and carted away, but as Harker remarked, "almost anywhere it would seem that a well sunk to depths of 7 ft. to 25 ft. will fill with water and give a more or less continuous supply."[2]

For a long time it was held by many that it was the Fullers' Earth that held up the water in the gravel, but in 1890 Harker discovered from fossils obtained from a shaft and boring at the Pumping Station, Lewis Lane, that it was Oxford Clay that performed this function—certainly in that neighbourhood. The sinkings proved the presence, due to faulting, of Oxford Clay, Kellaways Beds, Cornbrash and Forest Marble. Unfortunately there is not sufficient evidence to indicate the precise geographical extent of these deposits beneath the gravel-bed.

Waterworks of the Cirencester Urban District Council.—These waterworks are situate in the town, in Lewis Lane, and supply part of the Urban District and part of the parish of Stratton (Cirencester Rural District).

Powers.—Cirencester Order, 1891. Cirencester Water Act, 1897.

Limits.—Cirencester Urban District and parish of Stratton.

Sources of supply.—Wells and boreholes tapping water in the Great Oolite, Lewis Lane, Cirencester.

Works.—Pumping Station, Lewis Lane (completed, 1905). There is no filtration. The water is pumped to a service reservoir (204,000 gallons) in Earl Bathurst's park, from which it gravitates back through another main to which the houses are directly connected. Wentworth Jones, Surveyor of the Council, informs me that "the number of inhabited houses using town water is now [1st Dec., 1921] 1,222."

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[1] Seventh Report of the Commissioners on Underground Waters, *Rep. Brit. Assoc.* (York), 1881, p. 313. (Well for Messrs. Bowly & Son). J. Lucas, *Trans. Surveyors' Inst.*, vol. xiii, 1881, pp. 170, 171. J. H. Taunton, *Proc. Cotteswold Nat. F. C.*, vol. ix, 1886, p. 60, and coloured vertical section of the 1882-83 boring at Lewis Lane. Prof. Allen Harker, *ibid.*, vol. x, 1891, pp. 186-190, and vertical section of the 1890 boring at Lewis Lane. H. B. Woodward, 'The Jurassic Rocks of Britain' (*Mem. Geol. Surv.*), vol. vi, 1894, p. 509; and vol. v, 1895, p. 36. T. Hibbert and L. Richardson, *Proc. Cotteswold Nat. F. C.*, vol. xviii, 1913, pt. 2, pp. 175-184. Description of 1904 boring.

[2] *Proc. Cotteswold Nat. F. C.*, vol. x, pt. 2, 1891, p. 183.

Quantity of water supplied.—The daily average is 120,000 gallons. Supply is constant.

Quality of water.—Excellent (analysis, p. 256).

In 1871-72 the then Earl Bathurst had a boring made in a field near The Barton Mill to ascertain whether an adequate supply could be obtained there from the Great Oolite (p. 188). The result was apparently satisfactory, but for some reason or other the site was not adopted and the borehole has never been used. Instead, attention was given to a site in Lewis Lane, that occupied by the present Pumping Station of the Council.

From 1832 to 1882 the site of the Pumping Station was occupied by Messrs. E. Bowly and Son's Cotswold Brewery.

Previous to 1880 the brewery had obtained all its water from a well[1] 30 ft. deep and 3 ft. 6 in. in diameter sunk through 7 ft. of made ground, 12 ft. of gravel, 2 ft. of fine sand, into clay (Oxford Clay), and lined with cast-iron cylinders. The water was derived from the gravel-bed.

In 1880, however, owing partly to some doubt having been thrown on the purity of the water and partly to the necessity for an additional supply, Messrs. Bowly engaged Messrs. LeGrand and Sutcliff to make a 4-in. chisel bore from the bottom of the well. At first results were not very satisfactory, for Joseph Lucas stated : " On April 13th, 1880, I heard from Messrs. Bowly and Son, Cotswold Brewery, Cirencester, that they were on the point of abandoning the boring, by Messrs. LeGrand and Sutcliff, which was then 115 ft. deep, all but the top 26 ft. principally through clays,"[2] now known to be Oxford Clay, Kellaways Beds, Cornbrash and Forest Marble.

Lucas was at first of opinion that an adequate supply of water would be obtained from the junction of the Stonesfield Slate with the Fullers' Earth (to Messrs. Bowly and Son, 16th, April, 1880), but " Upon examining the country I found that the River Churn, which flows over the Great Oolite limestone from Baunton to Bowling Green Farm, north of Cirencester, flows from that point through the town over Forest Marble Clays for about a mile, when the Great Oolite is again thrown up to the bed of the stream by a large fault. Now it is just north of this fault that the boring is sunk. Finding the Great Oolite much fissured, and in itself favourable for transmission of water, which was supplied to it by the Churn, the conclusion was that the boring at the Cotswold Brewery, if continued, would draw upon this, and from the low situation of the brewery, that it would rise near the surface. After a little delay, the boring was continued. April 30th they struck a water supply at 122 feet, when the chisel jumped down 10 inches, and the water soon after rose in the pipe to within five feet of the surface. The boring was stopped at 128 feet, having entered the Great Oolite. On May 4th I heard the brewery pumps had been connected the day before, and were throwing half a barrel a minute. On July 6th a ' Special Pump,' placed just over the bore-pipe, was pumping thirty six gallons per minute, ' which is amply sufficient for all purposes.' On September 21st Messrs. Bowly wrote ' On testing the supply we found 90 barrels an hour ; but this is more than we require, so that, practically speaking, the supply appears inexhaustible '."[3]

The following record has been compiled from the particulars published by J. Lucas in the Table on p. 179 of his paper and from information supplied by Messrs. LeGrand and Sutcliff.

Boring at the Cotswold Brewery, Cirencester.—Commenced 15th March, 1880 ; finished 1st May, 1880.

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[1] This is the well referred to by Harker as " The well at Lewis Lane (Bowly's Well)." *Proc. Cotteswold Nat. F. C.*, vol. x, pt. 2, 1891, p. 185.

[2] *Trans. Surveyors' Inst.*, vol. xiii, 1881, p. 170.

[3] *Trans. Surveyors' Inst.*, vol. xiii, 1881, pp. 170-171.

		Thickness. Ft.	Depth. Ft.
	Well :—		
	Made ground	4	4
	Boring :—		
	Made ground	7	11
[Superficial Deposits]	Gravel	12	23
	Sand	2	25
	Blue clay	9	34
[Oxford Clay, Kellaways Beds, Cornbrash, Forest Marble]	Blue clay	17	51
	Bands of rock and clay ...	14	65
	Clay	15	80
	Stone	1	81
	Clay	13	94
	Bands of clay and stone ...	6	100
	Clay	3	103
	Bands of clay and stone ...	22	125
[Great Oolite]	Very hard stone bands ...	8	133
	[Limestone]	6	139

The borehole is lined from 3 ft. from the surface to 38 ft. down with 5-in. tubes and from 2 ft. 6 in. from the surface to 82 ft. 6 in. down with 4-in. tubes. Water-level.—6 ft. below the surface. Yield.—18 gallons a minute.

In 1882 the brewery, its houses, etc., were sold to Cripp's Brewery (now the Cirencester Brewery Co), and from them, in the same year, the Cirencester Water Works Company acquired the 'Brewery Well.'

In 1882-83, in order to supplement the supply, the Water Works Company had another 4-in. chisel boring made from the bottom of the well (see below), at a distance of 2 ft. to 2 ft. 6 in. away from the other hole. This second boring was taken to a depth of 109 ft. from the bottom of the well or 139 ft. from ground-level. It reached the Great Oolite at 119 ft. from the surface and was carried into that formation to a depth of 20 ft.

Boring at the Water Works, Lewis Lane, Cirencester.—Made.—1882-83. Record published by J. H. Taunton.[1] Street-level.—361 ft. above O.D.

		Thickness Ft.	In.
	Made ground	7	0
[Superficial Deposits]	Gravel	12	0
	Fine sand	2	0
[Oxford Clay, Kellaways Beds, Cornbrash, and Forest Marble]	Dark brown clay	1	6
	Blue clay	22	10
	Rock (blue)	15	5
	Clay (blue)	8	10
	Rock and clay (blue)	14	6
	Hard stone (blue)	11	2
	Rock and clay	9	4
	Hard stone (blue)	9	10
	Clay (blue)	4	7
[Great Oolite]	White rock	14	0
	Rock (cream-coloured)	6	0
	Total	139	0

Water-level.—9 ft. below the surface of the street.

The supply of water from this well still proved inadequate. Consequently, in 1890, the Water Works Company decided to sink a new shaft and borehole. The work was entrusted to The Aqueous Works and Diamond Rock Boring Company, of Lambeth (see below) and Taunton again watched operations.

[1] *Proc. Cotteswold Nat. F. C.*, vol. ix, 1886, table facing p. 60.

First a shaft 46 ft. 3 in. deep was sunk, 4 ft. 9 in. in diameter for 28 ft. 5 in.; 3 ft. 2 in. in diameter for 2 ft. 2 in.; and 3 ft. 9 in. for the remaining 15 ft. 8 in.

Taunton kept some of the fossils that he had obtained from the clay dug out of the shaft and showed them about June, 1890, to Allen Harker who was surprised to see that they indicated Oxford Clay.[1] His identifications were confirmed by Sharman and H. B. Woodward.[2]

Boring at the Waterworks, Lewis Lane.—Made.—1890 by the Aqueous Works and Diamond Rock Boring Company, Lambeth. Record published by Allen Harker.[3]

Diameter, 8½ in.: depth, 177½ ft.

The record given by Harker is not reproduced here because it is readily available and because it is held that it is more useful to give the record of another boring made close to in the Pumping Station in 1923-24, which went deeper and the cores from which were examined by the writer (see below).

From the well and borehole sunk in 1890 a sufficient quantity of water was obtained to meet the needs of the time.

In 1898 the Works of the Water Company were purchased by the Cirencester Urban District Council.

More water was soon required. Consequently, it was contemplated putting down an 18-in. borehole between the two 4-in. holes at the bottom of the 'Brewery Well.' It was found, however, that the two 4-in. holes had not been bored true: they were out of the vertical and converged. Also, it was discovered that the greater quantity of water supplying this well was not coming from a deep-seated source, but from the gravel-bed. Apparently the two boreholes had not proved satisfactory in the matter of obtaining water, so seven holes had been drilled through the side of the well to admit of water from the gravel-bed.

In 1904 this 'Brewery Well' was very wisely filled up, and a new borehole put down by Messrs. Thomas Tilley and Sons, of London (see below). This new borehole was intended to be 18 in. finished diameter, but it was found necessary to line it to a greater depth by a second lining 16½ in. diameter, as mentioned below.

Boring at the Waterworks, Lewis Lane (1904).—Made in 1904 by Thomas Tilley and Sons. Record published by T. Hibbert and L. Richardson.[4] Level of engine-room floor, 362 ft. above O.D.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
	1. Made ground	12	0	12	0
Superficial Deposits	1. Yellow gravel	3	6	15	6
	2. Clay	0	6	16	0
	3. Yellow gravel	5	0	21	0
Oxford Clay and Kellaways Beds (37 ft.)	4. Blue clay	26	6	47	6
	5. Hard loamy clay ...	1	0	48	6
	6. Blue clay	2	6	51	0
	7. Hard Blue clay	7	0	58	0
	8. Blue stone with shells ...	5	0	63	0
? Cornbrash (11½ ft.)	9. Hard blue stone with white vein	4	0	67	0
	10. Rotten clay with a band of stone	2	6	69	6
	11. Hard clay with a band of stone	5	0	74	6

[1] *Proc. Cotteswold Nat. F. C.*, vol. x, pt. 2, 1891, p. 186.

[2] *Id.*, p. 187; H. B. Woodward, 'The Jurassic Rocks of Britain,' vol v (*Mem. Geol. Surv*), 1895, p. 36.

[3] *Proc. Cotteswold Nat. F. C.*, vol. x, pt. 2, 1891, pp. 180-191, and section facing p. 185.

[4] *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2, 1913, p. 183. More minute classification is suggested above.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Forest Marble (64 ft. 1 in.)	12. Grey gault with stone	17	6	92	0
	13. Very hard grey marble stone	7	6	99	6
	14. Light blue clay and stone	17	0	116	6
	15. Hard blue clay and stone	6	0	122	6
	16. Hard light clay and flint	5	0	127	6
	17. Hard light stone bed ...	8	0	135	6
	18. Dark marl and bed of light stone	3	1	138	7
Great Oolite (121 ft. 5 in.)	19. Light marl	14	1	152	8
	20. Hard light stone... ...	19	4	172	0
	21. Light marl	9	0	181	0
	22. Hard light stone... ...	28	0	209	0
	23. Oolite, hard	7	0	216	0
	24. Very hard light stone ...	14	0	230	0
	25. Great Oolite (very broken)	30	0	260	0
'Passage Beds'	26. Stonesfield Slate ...	4	0	264	0
	27. Fullers' Earth	3	0	267	0

Chisel borer used from the surface to 181 ft. down. (When a depth of 181 ft. below the present engine-room floor was reached, and the end of the borehole was still in the Great Oolite, a temporary pump was put down to test the yield of water. It was found that it was not equal to 1,000 gallons per hour. Consequently, it was decided to put down a small 1-in. diamond-boring to a further depth of 50 to 60 ft. from the bottom of the borehole. The experiment proved satisfactory so the boring was continued from 181 ft. down to 267 ft.). Diameter of boring :—18-in. (internal diameter) cast-iron guide-pipe 6 ft. from the surface to 135 ft. 16½-in. (do.) wrought iron tubes 12 ft. 10 in. from the surface to 195 ft. 2 in. 12-in. open boring 195 ft. 2 in. from the surface to 259 ft. 6-in. open boring 259 ft. from the surface to 267 ft.

Rest-level of water.—The highest known rest-level—which occurred on three successive dates, namely, January 25th, 26th and 27th, 1912—was 5 ft. 4 in. down below engine-room floor. The lowest is about 22½ ft. and the average about 10 ft. Yield 16,700 gallons per hour. (When pumping at this rate the level of the water is depressed about 75 ft. below rest-level).

In 1923-24 a new borehole was sunk because the then existing standby plant was inadequate. At that time the Council had the 1904-Boring, 267 ft. deep, with pumping plant capable of delivery of 15,000 gallons per hour and a small steam plant on the 1890-Boring, and capable of only 5,000 gallons per hour. In view of the increasing demands it was decided to sink the new 15-inch borehole to a depth of 270 ft. and erect a pumping-plant capable of 17,000 gallons per hour.

Boring at the Waterworks, Lewis Lane[1] (1924).—Commenced October, 1923, finished August, 1924. Percussion, 20 in. diameter to 52 ft.; rotary, 20 in. diameter to 206 ft.; 15 in. diameter to 275 ft. Ht. above O.D. 362 ft.

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Made ground and gravel :—				
1. (River) Churn-side gravel composed of well-rolled fragments of Oolitic rocks ...	28	0	28	0
Oxfordian :—				
2. Oxford Clay. Clay, dark blue ... ... passing down into	24	0	52	0
3. Kellaways Beds. Limestone, dark grey, shaly, passing down into a more calcareous rock, and this into a fine-grained calcareous sandstone in which a fragment of an ammonite (*Proplanulites*) was found	6	0	58	0

[1] Richardson, L., *Proc. Geol. Assoc.*, vol. xxxvi, 1925, pp. 93-98.

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Cornbrash :—				
4. Limestone, rubbly, bluish-grey with an admixture of dark shaly matter. The bottom layer contains fragments of marl derived from the bed below. *Isocardia minima* J. Sowerby, *Cerithyris* aff. *intermedia* (J. Sow), *C. ovalis* S. Buckman	7	0	65	0
Forest Marble :—				
5. Marl, greenish-grey	8	0	73	0
6. Marble. Typical Forest Marble with oysters ; lignite	3	0	76	0
7. Marl, greenish-grey with conchoidal fracture	3	0	79	0
8. Marble (as above)	0	4	79	4
9. Marl (as above)	11	8	91	0
10. Marble (as above) with subordinate partings of shaly marl	10	3	101	3
11. Marl (as above) with, in the lower half, indurated layers at various horizons full of shell fragments	24	9	126	0
12. Limestone, shaly, with numerous oysters passing down into bluish-grey oolite and joined on to	5	9	131	9
Great Oolite :—				
13. Oolite, bluish-grey	4	3	136	0
14. Oolite, yellow	2	0	138	0
15. Oolite, bluish-grey	7	0	145	0
16. Oolite, mostly turned yellow and traversed by a fissure, lined with calcite crystals ...	1	6	146	6
17. Oolite, obscurely oolitic, bluish-grey, earthy, with black clayey films ...	1	6	148	0
18. Oolite, obscurely oolitic, bluish-grey, with some very hard fine-textured bands ...	6	6	154	6
19. Oolite, obscurely oolitic, light grey ...	2	6	157	0
20. Oolite, light grey, with numerous scattered ooliths, which soon weather dark when they have the appearance of glauconite-grains	1	8	158	8
21. Oolite, similar to preceding bed	2	9	161	5
22. Oolite, light bluish-grey, with films of black clayey matter	4	0	165	5
23. Oolite, bluish-grey, largely composed of comminuted shells...	1	4	166	9
24. Oolite	3	9	170	6
25. Oolite	2	0	172	6
26. Oolite, becoming yellow in the lower part ...	3	0	175	6
27. Oolite, yellow in the upper part, bluish-grey in the lower	3	0	178	6
28. Oolite, bluish-grey, with some very hard fine-textured bands	6	0	184	6
29. Oolite	1	4	185	10
30. Oolite, dark grey in the upper portion, yellow in the lower portion	1	6	187	4
31. Oolite, yellow	0	3	187	7
32. Oolite, in part a sparsely-oolitic cream-coloured 'flinty' limestone but with a pinkish tinge	0	4	187	11
33. Oolite, bluish-grey, mostly finely-oolitic (like a fine-grained Bath Stone), but creamy-yellow in the neighbourhood of a fissure which is lined with calcite crystals	4	0	191	11

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
34. Oolite	2	3	194	2
35. Oolite, hard, 'cavernous'	0	10	195	0
36. Oolite	2	6	197	6
37. Oolite, like bed 33	0	6	198	0
38. Limestone, rubbly; in part finely-oolitic, in part like a mudstone; in part bluish-grey; in part yellow	3	3	201	3
39. Solenopora Limestones. Oolite, light-grey, somewhat rubbly, shelly, with films of black clayey matter. *Solenopora jurassica* Nicholson	4	9	206	0
40. Limestones, light-grey, fine-textured with scattered small ooliths	12	0	218	0
41. Limestones, bluish-grey, earthy, very shelly —oysters mostly	2	0	220	0
42. Oolite, yellow, shelly, with cavities filled with yellow marl and a noticeable layer of yellow marl at the top...	2	0	222	0
43. Oolite, yellow, coarsely-oolitic, open textured and traversed by a fissure	6	0	228	0
44. Oolite, light grey, but in part yellowish passing down into Limestone, grey, sparsely-oolitic and very hard, with occasional dark-grey streaks of sandy indurated shale	26	6	254	6
'Passage Beds':—				
45. Limestone, light-grey, fine-textured, for the most part sandy to the touch, with, in the upper part, occasional cavities filled in with dark clay, and in the lower part, shelly, impersistent layers of limestone with sparsely-scattered ooliths ...	6	6	261	0
46. Alternating layers of Fullers' Earth clay and argillaceous limestone packed with fossils—*Pseudomonotis* sp., *Ostrea acuminata* J. Sowerby	8	0	269	0
47. 'Pisolitic' rock: Argillaceous rock (like indurated Fullers' Earth) with little pellets of a lighter grey or brownish-grey mudstone and well-rolled specimens of *Ostrea acuminata* J. Sow. Many of the shell-fragments and the surfaces of the internal casts of the shells and of the pellets are stained brown with oxide of iron	3	0	272	0
48. Limestone, hard, very light-grey, fine-textured, for the most part sandy to the touch. In places it is full of shell fragments—mostly of *Ostrea acuminata* J. Sow	3	0	275	0

Cased to 190 ft. below ground-level.

Owing to the deficient rainfall in the Spring of 1929 the level of the water below the floor level of the Waterworks in April, 1929, was lower than any level previously recorded for April, as the following table shows:

April 14th, 1921	...	...	...	15	feet	7	inches.
,, 13th, 1922	...	...	...	11	,,	2	,,
,, 12th, 1923	...	...	...	12	,,	0	,,
,, 10th, 1924	...	...	...	14	,,	10	,,
,, 9th, 1925	...	...	...	14	,,	6	,,
,, 15th, 1926	...	...	...	11	,,	8	,,
,, 14th, 1927	...	...	...	8	,,	2	,,
,, 12th, 1928	...	...	...	11	,,	8	,,
,, 11th, 1929	...	...	...	17	,,	9	,,

Somewhere about 600 houses are still dependent on wells 12 to 15 ft. deep in the gravel.

Well below Public Pump in Market Place, Cirencester.[1]—Surface-level.—364 ft. above O.D.

Harker says the depth of the well is 25 to 26 ft.; after passing through 7 ft. to 8 ft. of made ground there is about 20 ft. of gravel (which holds the water) resting on thick beds of impervious clays.

Wentworth Jones, Surveyor of the Council, informs me: "The well supplying the pump is 18 ft. deep, and normally yields quite a good supply, having in an ordinary season up to 9 ft. of water."

Well at Cirencester Brewery, Cricklade Street.[2]—Ground-level.—About 368 ft. above O.D.

I am informed by the Brewery Co. that, as stated by Harker, the well is 25 ft. deep, has a diameter of 2 ft. 3 in., and that the depth to the rest-level of the water on 22nd Jan., 1921, was 23 ft. The approximate average daily quantity of water used is 5,000 gallons. In the dry season of 1921 the rest-level of the water fell about 5 ft.

Well and borehole at Messrs. Alexander and Thompson.—Boring commenced 28th May, 1877; finished 26th June, 1877. Made and particulars communicated by Messrs. LeGrand and Sutcliff.

		Thickness Ft.	Depth Ft.
Dug well :—			
[No information]	... ...	165	165
Boring (5 in. diameter) :—			
[Great Oolite]	Stone	23	188
	Stone and sand	7	195
[? 'Passage Beds']	Clay and sand	12	207

Rest-level of water.—42 ft. below surface-level.

Well at Oakley Villas (now Oakley Hall), Cirencester.[3]—Surface-level.—409 ft. above O.D.

According to Harker this well is from 80 to 90 ft. deep and affords a never failing supply. "Mr. James Habgood . . . says . . . it has a high local reputation for purity on account of its great depth; but it is 'suspect' from surface contamination."

Well and borehole at Messrs. Cole and Lewis, Cotswold Bacon Factory.[4]—Surface-level.—405·2 ft. above O.D.

Harker states :—"A plentiful supply of water is here obtained at a depth of 89 ft. The well itself is 73 ft. deep, and there is a further bore of 16 ft. The height of the water was 11 ft. above the well floor three days ago [from 24th Feb., 1891]."

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[1] Bravender, J., *Rep. Roy. Comm. Water Supply*, 1869, Min. of Evidence, pp. 421, 422; Prof. A. Harker, *Proc. Cotteswold Nat. F. C.*, vol. x, 1891, pt. 2, pp. 182, 183.

[2] Harker, Prof. Allen, *Proc. Cotteswold. Nat. F. C.*, vol. x, 1891, pt. 2, p. 183.

[3] Harker, Prof. Allen, *Proc. Cotteswold Nat. F. C.*, vol. x, 1891, pt. 2, p. 181.

[4] Harker, Prof. Allen, *Proc. Cotteswold Nat. F. C.*, vol. x, 1891, pt. 2, p. 180.

In a letter written to W. Topley on 9th Oct., 1892, Harker says :—" The Bacon Factory Well. . . . They use about 20,000 gallons a day, but are only sensible of a daily diminution in supply, *i.e.*, there is a full supply for all their pump power in the morning, but it slacks off towards 6 p.m. They do not pump at night and find a full supply early in the morning. Water has fallen below shaft bottom since my paper."

Well at Further Barton.[1]—Harker records :—" This well is about 120 ft. deep. There is no record of the actual section, but most systematic records have been kept over a long series of years of the varying height of the water in the well. There can be no doubt, from these records, that it taps the Fullers' Earth at about the same depth as the R.A.C. Farm well. It has never been dry."

Well at the Royal Agricultural College Farm.[2]—Surface-level.—417 ft. above O.D.

Buckman stated that " The whole of this shaft was carried through beds of a more or less porous oolite, without a break either lithological or palaeontological . . . " to a depth of 140 ft. Harker remarked that " The depth mentioned, 140 ft., is somewhat greater than other evidence would have led one to expect, but we are ignorant of how far into the Fullers' Earth the sinking was carried." The well is not used now : the Council's water is laid on to the College, etc.

Well at The Beeches, Cirencester.[3]—(The site was ' Riverscourt,' Beeches Road). Harker wrote :—" Mr. W. Newcombe, builder, etc., of Cricklade Street, kindly informs me that this boring reached a total depth of 96 ft. From an examination of the triturated material of the boring, which Mr. Newcombe allowed me to see, I am of opinion that the boring went through a greater thickness of Forest Marble Clays than any of the previously described borings, and finished still in the freestone of the Great Oolite."

Well at Cirencester Station.—West side of railway-line about 66 ft. north of Cricklade Road. Communicated by E. Connal, Engineer to the former M. & S.W.J. Rly. (now G.W.R.), on 28th June, 1921.

Height above O.D.—350·6 ft. Depth of well (believed to be sunk through soil and clay into gravel).—14 ft. 9 in. Bottom of well.—335·6 ft. above O.D. Rest-level of water, 27th June, 1921.—340·5 ft. above O.D., and 10th May, 1920.—342·2 above O.D.

The well supplies the engines, workshops and station. The pump raises 2,000 gallons an hour without appreciably affecting the level of the water which mainly percolates through the gravel from the River Churn. From 12,000 to 14,000 gallons of water are drawn daily from the well. There is no great variation in yield, but about the end of April, 1920, the well was sunk 2 ft. 6 in. deeper, to its present level, owing to the water-level lowering. This was attributed to dry weather as the well, sunk about 1898, had always previously held enough water. Analysis, p. 255.

The few houses in Wiggold have water from The Exhibition Buildings tank (Baunton Supply, p. 54).

Barton Mill Boring.—Made for Earl Bathurst in 1871-72. Rocks penetrated described by J. H. Taunton.[4] Ground-level.—363·5 ft. above O.D.

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[1] Harker, Prof. Allen, *Proc. Cotteswold Nat. F. C.*, vol. x, 1891, pt. 2, p. 180.

[2] Buckman, Prof. James, *Proc. Cotteswold Nat. F. C.*, vol. ii (1860), p. ii ; Allen Harker, *ibid.*, vol. x, pt. 2, 1891, p. 180 ; H. B. Woodward, ' The Jurassic Rocks of Britain,' vol. iv (*Mem. Geol. Surv.*), 1894, p. 510.

[3] Harker, Prof. Allen, *Proc. Cotteswold Nat. F. C.*, vol. x, 1891, pt. 2, p. 181.

[4] *Proc. Cotteswold Nat. F. C.*, vol ix, 1886, p. 60, and table facing p. 60 ; see also T. Hibbert and L. Richardson, *ibid.*, vol. xviii, pt. 2, 1913, pp. 176-177.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
	Top soil	2	6	2	6
River Gravel	Gravel	11	6	14	0
	Rough gravel	3	6	17	6
	Shingle } 1. Loose rock }	8	6	26	0
Great Oolite	2. Light-coloured rock	2	7	28	7
	3. Stout blue clay	1	2	29	9
	4. Light-coloured rock	3	0	32	9
	5. Yellow marl	0	8	33	5
	6. Light-coloured rock	1	3	34	8
	7. Yellow marl	0	6	35	2
	8. Light-coloured rock	2	10	38	0
	9. Soil with black sand. Possibly a Dirt Bed which it much resembled	1	0	39	0
	10. Yellow marl	0	3	39	3
	11. Hard blue rock	2	9	42	0
	12. Light-coloured rock	2	0	44	0
	13. Marl	0	4	44	4
	14. Hard blue rock	2	10	47	2
	15. Hard white rock...	1	5	48	7
	16. Yellow marl	0	4	48	11
	17. Hard white rock...	3	6	52	5
	18. Yellow marl	0	3	52	8
	19. Light-coloured rock	1	10	54	6
	20. White marl	0	3	54	9
	21. Light-coloured stone	1	9	56	6
	22. Blue sandy marl...	0	5	56	11
	23. Light-coloured stone	2	0	58	11
	24. Yellow marl	0	3	59	2
	25. Hard stone with layers of marl (light colour)	10	9	69	11
	26. Stone, light colour, with layers of marl	6	1	76	0
	27. Hard rock, light colour, and yellow marl	6	1	82	1
	28. Stone, light colour, with thin layers of marl	7	0	89	1
	29. Stone with water	1	0	90	1
	30. Marl	0	8	90	9
	31. Stone charged with water ... Water rose 2 ft. above the surface of the ground.	0	9	91	6
	32. Stone, light colour with thin layers of marl	17	7	109	1
'Passage Beds'	33. Blue stone with layers of marl ... At 117 ft. 2 in. more water rose to the surface.	8	1	117	2
	34. Stone with layers of marl (light bluish colour)	21	6	138	8
	35. Blue stone with layers of marl ...	3	7	142	3
	36. White stone with layers of marl	5	9	148	0

Remarks.—This boring was made by the then Earl Bathurst to ascertain whether an adequate supply for the town could be obtained here from the Great Oolite. J. H. Taunton was engaged to watch the boring operations, and on July 16th, 1872, reported to the Sanitary Committee of the Cirencester

Town Commissioners as follows[1] :—" A boring 3¼ inches in diameter has been sunk there [near The Barton Mill] for a depth of 148 feet from the ground-surface down to the Fullers' Earth formation. At 91 feet 6 inches, after piercing a bed of marl, the loose rocks of the Great Oolite were found charged with water, which ascended the bore-hole with great force as an artesian spring from January 6th to March 2nd, delivering at one time (during the week ending January 27th [1872]) 29 gallons of water per minute.

" Again, after piercing 8 feet of impervious beds in the Great Oolite at a depth of 109 to 117 feet from the surface, more water was tapped and ascended to the surface.

" The boring was continued until it was found to have been carried into the upper beds of the Fullers' Earth. I have had the advantage of Mr. [Prof. James] Buckman's assistance in determining this point.

" The work, although of an experimental character, has been successful in obtaining so large a supply of spring water at the site in question, that, with the gravel-bed supply procurable there, I believe enough water has already been found to meet the general requirements at Cirencester."

For some reason or other The Barton Mill site was not adopted, and the borehole has never been made use of.

A sample of the water was submitted on the 8th January, 1872, to Prof. A. H. Church, M.A., F.C.S., of the Royal Agricultural College, who reported : " This water corresponds in general character and in chemical composition to the best deep well waters of this district. It is quite suitable for drinking purposes and for ordinary domestic uses.

" The hardness of this water is 14·95 degrees, reduced to 4·9 degrees by boiling. One imperial gallon contains 21·42 grains of total residue or saline matter. Of this residue 2 grains are sulphate of lime and 1·49 grains common salt. The colour, odour and taste of this water are quite satisfactory.

Well and Boring at Ewepens.—(This is the name of the farm-buildings a little to the north of Pope's Seat, Cirencester Park.) Made in 1898 by H. J. Godwin, Quenington, under direction of A. J. Henderson. Particulars communicated by T. Hibbert : classification by L. Richardson.

Ground-level.—505 ft. above O.D.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
	Well (depth 130 ft.) :—				
[Great Oolite]	Light coloured rock	100	0	100	0
['Passage Beds']	Sand. A little water ...	0	6	100	6
	Clay	1	6	102	0
	Rock	1	8	103	8
	Clay	1	8	105	4
	Rock	1	0	106	4
	Blue marl	3	4	109	8
	Rock	2	8	112	4
	Blue marl	2	4	114	8
	Blue rock	1	4	116	0
	Hard grey rock	14	0	130	0
	Boring (220 ft.) :—				
	Sand	1	3	131	3
	Clay	4	9	136	0
	Hard blue rock	9	6	145	6
	Sand	1	0	146	6

[1] Copies of this letter are deposited at the Public Library, Gloucester, the Bingham Library, Cirencester, and at the office of the Surveyor to the Cirencester Urban District Council.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
[Fullers' Earth]	Blue clay	3	0	149	6
	Hard blue rock	11	9	161	3
	Clay	2	0	163	3
	Rock	7	4	170	7
	Clay	1	8	172	3
	Hard rock	2	0	174	3
	Clay	1	10	176	1
	Rock	5	0	181	1
	Clay	5	8	186	9
	Hard rock	14	6	201	3
	Hard clay	9	3	210	6
	Rock	2	0	212	6
	Hard clay	3	9	216	3
[Inferior Oolite])	[? Clypeus Grit and Upper Trigonia Grit] Hard rock...	19	0	235	3
	Hard yellow rock (Bath Stone [*sic.*])	28	9	264	0
	Hard grey rock	6	9	270	9
[? Cotteswold Sands and Upper Lias Clay]	Sand	1	3	272	0
	Yellow sandstone	24	9	296	9
	Blue clay	1	3	298	0
	Hard blue rock	8	9	306	9
	Soft grey stone	8	9	315	6
	Grey stone, variable ...	10	9	326	3
	Soft yellow stone	5	9	332	0
	Light blue clay	1	0	333	0
	Soft grey stone	6	0	339	0
	Blue rock and blue clay in thin layers	11	0	350	0

Louis C. Wrigley informs me that water was struck in the soft yellow stone at 23 ft. above the bottom of the well, the supply, however, is very uncertain.

In the Geological Survey Office there is correspondence concerning this well between Robert Anderson and H. B. Woodward. Anderson sent Woodward particulars of the rocks penetrated and their thickness down to 254 ft.: not below. These particulars differ somewhat—but not to any important degree—from those given above. Anderson stated (*in litt*, 19th Dec., 1898): "... we have at last struck water at a depth of 340 feet and have bored to 350 ft. The water has risen to 120·6 [ft.] from the surface of the ground. ..."

Coleford—Maps: 233; [43 S.W.]; (30 S.E., 38 N.E.)

The public supply of Coleford is obtained from a spring issuing from the Coal Measures in 'The Coombs' hill. The water is conveyed in iron pipes to a reservoir (45,000 gallons), from which it is laid on to most houses where pressure permits and to standposts in various parts of the town. A pipe is laid from 'Trapnell's Level' to drain off the spring water that collects there.

There is a large number of wells in the Urban District, varying in depth from 20 to 100 ft., but the majority are shallow.

The provision of an adequate supply of water, under sufficient pressure, has long been the chief sanitary requirement of the District. In 1903 the Council had a boring made through Lower Limestone Shales into the Old Red Sandstone in Bircham Wood (see Newland); but without success. Consideration has also been given to the Millpond Pit, where a sufficient quantity of water was found, but it was not fit for use. A considerable sum was expended on improving this source of supply, but no use has been made, as

yet, of the water. W. H. Davis, Surveyor and Sanitary Engineer, Coleford, has sent me the following particulars :—

Depth of shaft at completion	147 ft.
Diameter of shaft : top	7 ft. 6 in.
bottom	4 ft. 6 in. but irregular throughout.
Depth to rest-level of water ex surface ...	19 ft.

Test-Pumping.—Rest period between cessation of sinking and pumping at 8.15 a.m., Nov. 11th, 1914, and commencement of test-pumping 9.30 a.m., Nov. 16th, 1914.

The following note is important before dealing with the table : The work of sinking commenced in August and pumping early in September, thus the water-bearing strata were being continuously drained for over two months.

Table of Water Depths and Time Resting.

	Rest after sinking ceased Hours.	Depth of water in shaft Ft.	In.
11th November, 1914	19½	78	0
12th ,, ,, ...	21	81	0
13th ,, ,, ...	43½	99	0
14th ,, ,, ...	67	101	6
15th ,, ,, ...	—	—	—
16th ,, ,, ...	109½	104	6

Actual Pumping Test.—After 96 hours continuous pumping the water-level was lowered 7 ft. The volume of water discharged during test-pumping was 2,582 gallons per hour.

W. H. Davis informs me that the water is ' mineral water,' irony, and that the irony water issues from the upper strata and spoils that derived from the lower.

In August, 1922, application was made for a grant from the Unemployment Grant Committee to obtain water from the stream originated by two springs in Birchen Wood, south of Staunton, and joined by the waters from a spring rising immediately west of Bond's Wood, but in Knockall Enclosure, below the entry of the water from the Knockall-Enclosure spring.

Some of the houses composing the hamlet of Scowles have rainwater tubs, but the majority of the people fetch their water from " Crow's Nest Pump " in the disused Scowles Iron Pit. The pump draws water from pools far down in the old workings, and the bulk of the water feeding these pools comes from a heading in the direction of the old Crow's Nest Pit. When water fails at the pump the people have either to scramble down underground to the pools or go to the standpost near High Meadow (p. 125).

Kingswood (near Bristol)—Maps : 264, 265 ; [35] ; (72 S.E., 76 N.E.)

Kingswood Urban District is on the Coal Measures and most of the houses are supplied by the West Gloucestershire Water Company.

" During 1914 they [W. Glos. Water Co.] opened up their reserve supply at California, and installed a pumping, softening and filtering plant. . . . Owing to certain difficulties, partly due to the war, the hardness of the California water at times exceeded 18°[1]."

Boring at Douglas Motors, Ltd.—Site.—At Works. Made for Messrs. Douglas by, and particulars communicated by Messrs. C. Isler and Co., Ltd.

Surface-level.—350 ft. above O.D.

[1] Perrott, Dr. C. J., in Medical Officer of Health Report for 1914, 1915, pp. 85, 86, *Glos. C. C.*

		Thickness Ft.	Depth Ft.
	Top soil	1½	1½
Coal Measures	Grey mottled clay	3	4½
	,, ,, and stones ...	8½	13
	Black shale	8	21
	Pennant Grit	12	33
	,, and layers of shale ...	9½	42½
	Hard clay with coal streaks ...	13	55½
	Grey rock	4½	60
	Broken shale and layers of grey rock with thin layers of coal	55	115
	Grey rock	23	138
	,, and layers of shale ...	24	152
	Broken shale layers. Grey rock ...	28	180
	Coal	1	181
	Bastard fireclay	5	186
	Shale layers. Grey rock	16	202
	Broken shale	19	221
	Grey rock	9½	230½
	,, and layers of shale ...	38	268½
	,, ...	14	282½
	,, and black shale	19	301½
	,, and layers of shale ...	37	338½
	Coal and black shale...	2	340½
	Grey rock and shale	28	368½
	,, ...	9	377½
	,, and layers of shale ...	16½	394
	,, ...	39	433

The Works Engineer informs me (24th Jan., 1922) that "the boring proved an unsatisfactory undertaking. The most water it yielded was 100 gallons in 5 hours. The whole affair was abandoned and never used."

West Gloucestershire Water Company.—(Offices.—Kingswood Hill, near Bristol.)

Supplies Kingswood U.D. (part); and parishes of Nettleton (part) (Chippenham R.D.); Acton Turville, Chipping Sodbury (part), Dodington (part), Doynton (part), Filton (part), Frampton Cotterell (part), Great Badminton, Hawkesbury (part), Horton (part), Old Sodbury (part), Stoke Gifford (part), Tormarton (part), Westerleigh (part), Wick-and-Abson (part), Wickwar (part), Winterbourne (part), Yate (part), (Chipping Sodbury R.D.); Corston (part), Keynsham (part), Newton St. Loe (part), Saltford (part), Whitchurch (part) (Keynsham R.D.); Sopwith (Malmesbury R.D.); Didmarton (Tetbury R.D.); Almondsbury (part), Alveston (part), Olveston (part), Redwick and Northwick (part), Thornbury (part), Tytherington (part) (Thornbury R.D.); Bitton (part), Hanham Abbots (part), Mangotsfield (part), Oldland (part), and Siston (part) (Warmley R.D.).

Powers.—West Gloucestershire Water Acts, 1884, 1887, 1899, 1902, 1909 and 1914; West Gloucestershire Water Order, 1911.

Limits.—The above parishes and Alderley, Dyrham and Hinton, Iron Acton, Little Sodbury, Old Sodbury, Pucklechurch, Wapley and Codrington (Chipping Sodbury R.D.); Chelwood, Chen Magna, Chen Stoke, Norton Malreward, Publow, Stanton Drew (Clutton R.D.)[1]; Kingswood (part), Wotton-under-Edge (part) (Dursley R.D.); Burnett, Compton Dando, Kelston, North Stoke, Queen Charlton (Keynsham R.D.); Alkington, Berkeley, Breadstone, Charfield, Cromhall, Elberton; Ham and Stone, Hamfallow, Henbury (part), Hill, Hinton, Littleton-upon-Severn, Rockhampton, Tortworth (Thornbury R.D.).

[1] The parishes of Clutton R.D. are excluded from the limits of supply by the Act of 1914.

Sources of Supply (Nature and Sufficiency).—(1) Wells in Pennant Grit, Frampton Cotterell (two—360 ft. deep); (2) Well in Pennant Grit "Cowhorn" Warmley (about 200 ft. deep); (3) Well in Pennant Grit "California," Oldland (about 500 ft. deep). The approximate average daily quantity of water derived from each source is, respectively, (1) 750,000 gallons; (2) 191,500 gallons; (3) 410,960 gallons.[1]

Works.—Mechanical Filters. Service reservoirs:—Kingswood (Hopewell Hill), (*a*) 2,250,000 gallons, (*b*) 100,000 gallons; Old Sodbury, 75,000 gallons; Petty France, 10,000 gallons; Thornbury, 56,000 gallons; Whitchurch, 60,000 gallons. Pressure is sufficient.

Quantity of Water Supplied.—The daily average is 1,058,000 gallons.

Quality of Water.—Quarterly bacteriological examination. Analyst remarks (22nd Dec., 1913) that bacterially the water is well adapted for a public supply. Hardness:—(1) 16·0°; (2) 28° (18° after softening). No action on lead.

Nailsworth—Maps: 234, 251; [34, 35]; (49 S.W., S.E., 57 N.E.)

This Urban District embraces portions of the Nailsworth, Horsley and Avening Valleys with certain tributary combs and associated high ground.

Nailsworth Urban District is supplied by the Stroud Water Company from their high level reservoir on Minchinhampton Common. There is a small service tank at Forest Green. There are also several private supplies, numerous public springs and drinking fountains, a few wells, and in some cases rain-water is stored. The district is now well supplied.

Springs issue from two horizons, from (1) the basement beds of the Great Oolite or thereabouts, known as the 'high' or 'top-level springs'; and (2) at or near the base of the Cotteswold Sands, known as the 'bottom' or 'low-level springs.'

The water of the top-level springs is hard. The springs are usually collected by means of stone drains, stones placed on each side, on the top, but not on the bottom. The bottom is on bare Fullers' Earth clay, but very soon the clay-bottom becomes covered with a deposit of carbonate of lime, or "callice" as it is locally called. The water is then conveyed to tanks and thence by iron pipes to the places it supplies. To be kept free from a deposit of 'callice' or from 'callicing,' pipes must be kept full. Examples of private supplies from top-level springs are those at The Hollies, Rockness House and Ringfield Farm.

Good top-level springs are those (1) in the hillside south of All Saints Church, Shortwood, some of which have been piped to troughs (such as that near the School) for the use of cottagers living around; and another which furnishes a supply to Hillier's Bacon Curing Factory; (2) above Rockness, which has been piped to Rockness House and Barne's Close; and (3) near Rowden.

The water issuing from the Cotteswold Sands, from which it is thrown out by the Upper Lias clay, has a very constant temperature, summer and winter, of 42°. The water that issues from the Sands has percolated through the Inferior Oolite. The Oolite exposed in quarries 'steams' in frosty weather and all the year round 'musty smelling air' rises from 'lissens' in it. This steaming has gained the expression, often used locally, of 'hot rock' and of houses being situate on 'hot rock.'

Notable springs issuing from the Cotteswold Sands are:—(1) near Newmarket Mills (demolished). Water from a spring here is pumped to Hillier's Bacon Curing Factory; (2) at Springhill, the water of which is conveyed to a tank from which there are two pipes, one to supply Axpills and Cossack Square; the other, Day's Mill, and The Fountain and Lloyds Bank in

[1] Information supplied by S. F. Andrews, Secretary, West Gloucestershire Water Co., 15th June, 1921.

Nailsworth ; (3) at Gig Mill : one feeds a ' dip,' the other a brick tank close by on a level with the mill-pond from which the water is piped to Nailsworth Brewery (now closed), two mills and four cottages ; (4) in Millbottom. The Millbottom Spring is a very copious spring used by those living in the vicinity, but otherwise running to waste. In the bottom at Harleywood where by the path-side close to the southern end of the mill-pond is " Sweetwater Spring " ; (5) at the bend of the road between Holcombe Mill and Weighbridge Inn on the Avening road, a small but constant spring ; (6) that used to supply Holcombe House and The Hermitage.

Care requires to be exercised in determining springs in this district ; many so-marked springs on the 6-inch map are ' spout-springs ' and springs originating from leaky or disconnected old drains, draining clay-slips.[1]

Newnham—Maps : 234 ; [43 S.E.] ; (31 S.E., 32 S.W., 39 N.E., 40 N.W.)

Some 45 houses of this Urban District are supplied by a private undertaking of which the following are particulars :—

Providers.—Executors of the late S. W. Woods (constituting for this purpose a Water Company).

Area of Supply.—Part of Newnham U.D.

Sources of Supply.—Springs from the Old Red Sandstone, intercepted underground. Gathering-ground, Blaize Bailey (about a mile west of Newnham), 20 acres. Daily yield—according to the Secretary to the Company—" equal to 11,000 gallons per day at midsummer."

Works.—No filtration. Reservoir at Blaize Bailey, 50,000 gallons.

Quantity of Water Supplied.—The daily average is 4,000 gallons.

Quality of Water.—Excellent. No plumbo-solvent action.

In spite of the yield of the springs and the capacity of the reservoir those connected to the supply are often short of water during a dry summer. Surgeon-Capt. O. W. Andrews, the Medical Officer of Health, in his Annual Report for 1909 (p. 14) suggested that :—" the supply might be readily increased by cutting adits, and that by damming up the gully below the present reservoir the storage capacity could be very considerably increased at no great cost."

The greater part of Newnham town is on the Upper Keuper or Arden Sandstone.

H. E. W. Hook, the Sanitary Inspector, has sent me the following particulars concerning certain wells in Newnham :—(1) Well in Bailey's Entry supplying six houses with water. 55 ft. deep, 20 ft. of water. (2) Well at Brightlands School. 65 ft. deep, 20 ft. of water. The Analyst's report states that the water is good but slightly medicinal. (3) Well at The Green. 65 ft. deep, 20 ft. of water. (4) Well in High Street (Mr. Mills). 55 ft. deep, 25 ft. of water. (5) Well at Undercliff Cottage. 25 ft. deep, 10 ft. of water.

All the above wells are in red marl and sandstone and the last is the only one which, to Mr. Hook's knowledge, has ever shown any variation according to the tide, and this has not happened since the well was deepened some years back.

The depth of the wells in the red marl tract outside the town varies from 25 to 50 ft., and the supply of water (analysis, p. 268) in the wells is satisfactory.

A large spring was encountered in cutting the tunnel under The Haie through the Upper Keuper Sandstone and associated marls and the Old Red Sandstone against which the former are faulted. The water is brought by pipe to Bullo by the Great Western Railway Company and supplies about six houses there and the engine sheds.

[1] I am indebted to G. H. Pavey-Smith of Nailsworth, for much of the information given above.

The dip of the Old Red Sandstone in the western portion of the District is westerly. Consequently most of the rain water works away in that direction. with the result that only insignificant streams flow eastwards.

Stow-on-the-Wold—Maps: 217; [44]; (22 S.W.)

As might be expected from the nature of the beds and the occurrence of low ground south, east and west of the town the supply of a pure and adequate quantity of water has long been a difficult problem. Previous to 1836 and, with the exception of a few houses, until 1868 all the water that was required had to be fetched from Stow (or the 'Upper') Well on the Broadwell road. W. Bartlett informs me that there never were any private wells in Stow with the exception of one at the brewery and one at the Workhouse (which is in Maugersbury parish), but that neither of these is now in use.[1]

In 1867 a Committee of Ratepayers, to which the Vestry deputed its powers, acquired a well at the back of the George Hotel on the site on which the present Police Station and Petty Sessional Court now stand. A water-tower was erected and the Works were opened on February 19th, 1868. This "District Well," as it was called, did not prove satisfactory owing to the water becoming polluted. Consequently, the chief problem that confronted the Local Board on its inception in 1872 was the provision of a suitable supply. The Commissioners for enclosing lands in the parish of Broadwell vested in the Stow Local Board, Stow Well (the 'Upper Well'), Horse Well (the 'Lower Well,' situate some 150 yds. lower down the hill), and Bumblebee Well (170 yds. east of the latter), together with certain lands, etc. These wells, really springs, derive their supply from the high ground to the north and north-west, the water having percolated through the Oolites and Cotteswold Sands. The natural course of the waters intercepted by these wells is into the depression to the south of the road in which they give rise to the Caudwell Brook. The Local Board considered a scheme to utilize these 'Caudwell Springs,' which would have proved expensive, but just as it was about to be carried out H. Teague offered to attempt to increase the supply and prevent the pollution of the water in the 'District Well.' Teague succeeded and the well has been the source of supply ever since.

The engineer states that the well is 130 ft. deep, "in limestone from top to bottom," but "the bottom is sand and gravel, and more especially sand." This suggests that the well terminates in Cotteswold Sands, but the water tapped is not derived solely from the Sands. It includes some of that which falls on the Oolite above. The Oolite is traversed by fissures and it is in such that water collects and circulates. Therefore in the absence of a clay capping or of adequate, interstratified, continuous and undisturbed layers of clay care has to be taken to guard against surface-pollution. The depth of water in the well varies from 6 to 15 ft.: occasionally in periods of drought, it is less than 6 ft. The average daily yield is 20,000 gallons. The water, which is not filtered, is pumped to a tank (capacity—25,000 gallons), whence it is distributed. Half the houses are still dependent on standposts (analysis, p. 275).

Stroud—Maps: 234; [34, 44]; (41 S.E., 42 S.W., 49 N.E., 50 N.W.)

The lowest part of the district is floored with Middle Lias—Sandy Beds succeeded by Marlstone. Above comes, in ascending sequence, Upper Lias clay, Cotteswold Sands, Inferior Oolite, Fullers' Earth and Great Oolite. Springs issue (1) the 'Low Level' from at or near the base of the Cotteswold Sands, from which they are thrown out by the Upper Lias clay, and (2) the 'High Level' from at or near the base of the Great Oolite, from which they

[1] Bartlett, W., has given some interesting information on the history of the water-supply of Stow in his book on *Nineteenth Century Stow*, 1911.

are thrown out by the Fullers' Earth. A gravel-bed rests on the Middle Lias and forms a terrace along the right bank of the Frome from Gannicox westwards into Caincross parish.

The Urban District is supplied by works belonging to the Council (supplemented, when necessary, by water procurable from the Stroud Water Company), springs and wells.

Stroud Urban District Council's Waterworks.—There are two sources of supply: (1) the Stroud Hill Supply, and (2) Gainey's Well.

The Stroud Hill Supply is derived from some eighty shallow springs thrown out by the Fullers' Earth between the Bisley Road reservoirs (capacity 2,000,000 gallons: height above O.D. 537 ft.) and Sydenham's Farm, and collected into 4-in. and 6-in. iron pipes (*via* below Kilminster, Fennel's and Ansteads Farms) 2⅔ miles long. The yield of the springs varies from 15,000 (summer) to 200,000 (winter) gallons per day. Analysis, p. 275.

Gainey's Well is a 'Low Level' spring issuing from at or near the base of the Cotteswold Sands, but the actual outburst of water is below the usual level owing to it emerging from the base of a slipped mass of Inferior Oolite. The yield varies from 60,000 (summer) to 110,000 (winter) gallons per day. Analysis, p. 275.

Wells in use in the district vary in depth as a rule according to their position in respect of the water in the Cotteswold Sands. Locally, however, there has been much down-sliding of rock on the hill sides with the result that frequently the first appearance of water and the positions of wells are not precisely where they would be expected to be from the study solely of the geological map.

Farmhill Well.—This well, in a field to the east of Farmhill Park, supplies Farm Hill. It is 45 ft. deep and penetrates '20 ft. of rock rubble and sandy freestone, with yellow clay at the base; below this was 10 ft. or so of slate-coloured clay and several feet of loose reddish grit like sea sand and gravelly rubble with water'[1], disturbed Inferior Oolite, Cotteswold Sands and Upper Lias clay. Water was encountered at 24 ft. down, and it is said that there is never less than 12 ft. of water in the well.

There are a number of springs, mostly small, in the District, issuing from at or near the base of the Cotteswold Sands.

Borings through the Middle Lias into the Lower Lias in search of water are not recommended. What little water that might be obtained would probably be saline and possibly be impregnated with sulphuretted hydrogen.

Wells at Stroud Brewery.—This brewery is adjacent to the G.W.R. Station and obtains its supply from springs and wells at some distance. Three borings, however, have been made on the premises through the lower portion of the Middle Lias into the Lower Lias. Two are said to have been successful.

Boring No. 1.—By Messrs. C. Isler & Co., Ltd. Depth about 300 ft., yield satisfactory.

Boring No. 2.—By Messrs. C. Isler & Co., Ltd. Completed Jan., 1906.
Dug well:—[Clay principally]—70 ft.
Boring:—Clay with layers of rock—330 ft.; 25 ft. of 10-inch tubes, top 42 ft. down. Yield.—Nil.

Boring No. 3.—By Messrs. LeGrand, Sutcliff & Gell, Ltd. Completed May, 1906.
Boring:—Clay with layers of rock—298 ft.; 30 ft. of 8½-in. tubes, top 5¼ ft. down; 276 ft. of 7½-in. tubes, top 4 ft. down. Yield.—3,240 gallons per hour.

Boring at Callowell.—Borehole in garden of Plough Inn. Made 1925.

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[1] Prof. [Sir] W. F. Barrett, *Proc. Soc. Psychical Res.*, vol. xv, 1900, p. 331.

		Thickness Ft.	Depth Ft.
	Stone brash	5	5
[Upper Lias]	Clay	2	7
	Stone	2	9
	Clay	67	76
	Stone	0½	76½
	Clay	0½	77
	Stone, water found, 800 gallons per min.	3	80
	Clay	31	111
	Blue clay	18	129
	Stone [Grey-blue hard argillaceous limestone]	3	132
	Clay [Brown sandy micaceous clay]	1	133
	Blue clay	3	136
	'Jointy' stone. Water lost ...	1	137
	Stone	3	140
	Sandy clay	4	144
[Marlstone]	Stone [Marlstone]	10	154

Particulars given in parentheses were obtained by the writer from an examination of samples.

Tetbury[1]—Maps: 251; [34]; (58 S.W.)

The town is supplied from two boreholes at the Urban District Council's Pumping Station, Blind Lane, in Tetbury Upton parish, distant ¾ mile north by west of Tetbury Church—(1) a brick-lined circular well 9 ft. 10 in. deep and 6 ft. 9 in. in diameter from the bottom of which is a 7-in. borehole 290 ft. 2 in. deep which leaves off 48 ft. down in the Inferior Oolite and 87 ft. above its base; (2) a borehole 446 ft. deep which leaves off 55 ft. down in the Cotteswold Sands.

Boring (1) was made in 1892 by T. Holloway, of Chippenham. H. B. Woodward records that "Water was tapped in a fissure at 147 ft. [in the Great Oolite], and it rose 28 ft. (to 119 ft. from the surface) and there stood; but the quantity was insufficient. At 300 ft. (after the boring had been stopped for a time) pumping was again resorted to, and 2,964 gallons per hour were obtained. The pumping was continued for a fortnight without lowering the level of the water which remained at 119 feet from the surface. The boring had been tubed to a depth of 250 feet, and with perforated tubes from 250 to 270 feet. The water then obtained was derived from the Inferior Oolite."

Boring (2), made in 1915 is in use and the rest-level of the water is 167 ft. below the engine-room floor.

Works.—No filtration. Service reservoir.—Blind Lane (at the Pumping-Station), capacity—80,000 gallons. Pressure sufficient.

Yield.—The water from the two boreholes is pumped to the service reservoir. The yield from the new borehole (2) is between 5,000 and 6,000 gallons an hour. The old pump supplied 500 to 600 gallons per hour from boring (1).

The late T. V. H. Davison informed me that the 1915-borehole struck a fissure in the Great Oolite, and while boring operations were in progress he

[1] Holloway, Thomas.—Report to the Chairman and Members of the Tetbury Local Board, 1890. Woodward, H. B.—Report on the site for a well and reservoir at Tetbury, Feb. 18th, 1891. Woodward, H. B.—'Jurassic Rocks of Britain,' vol. iv, (*Mem. Geol. Surv.*), 1894, p. 508. Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xix, pt. 1, 1915, pp. 25-28. Richardson, L., *ibid.*, pp. 57-66. Weaver, H. J.—Deep Bore-hole, Pump and Machinery [at Tetbury U.D.C. Waterworks] *The Engineer*, July 21, 1922, p. 64.

noticed that the water of the spring that breaks out in the bed of the Avon at the Tetbury Sewage Works was quite milky. Analysis, p. 276.

Boring at Tetbury Waterworks.—Three-quarters of a mile north by west of Tetbury Church. Section recorded by L. Richardson.[1] Made 1915. Ground-level.—447 ft. above O.D. Shaft.—9 ft. 6 in. 18-inch rotary-boring.—147 ft. 3 in. 13-inch rotary-boring.—289 ft. 3 in. Total depth.—446 ft.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Forest Marble (21 ft. 3 in.)	In shaft.—Typical Forest-Marble limestones with numerous specimens of *Ostrea sowerbyi* Lyc. and, on weathered surfaces, small gastropods, etc., ...	9	6	9	6
	Borehole.—Similar limestones in thin layers with partings of brown clay	8	3	17	9
	Very similar, but less shelly limestones, with small "clay galls"	3	6	21	3
Great Oolite (103 ft. 9 in.)	Limestone, brownish, oolitic ...	2	0	23	3
	Sand—according to the foreman...	2	3	25	6
	Limestones, brownish-grey, coarsely oolitic, with few shells, but on the nether side of the lowest bed were noticed *Ostrea sowerbyi* Lyc., *Entolium demissum* (Phil.), and echinoid radioles. Wood in places	12	0	37	6
	Marl, brown	3	0	40	6
	Limestone, grey, oolitic ...	1	6	42	0
	Clay, tough, brown and greenish-grey	0	2	42	2
	Limestone, brownish, oolitic, somewhat resembling certain of the browner and less shelly layers in the true Forest Marble with occasional small flat "clay galls"	1	4	43	6
	Limestones	1	9	45	3
	Limestones in thin layers with clay partings	1	2	46	5
	Limestone: shell fragments in places	1	6	47	11
	Clay, brown	0	1	48	0
	Limestone, similar to 13 ...	1	6	49	6
	Limestone, impure, oolitic, with which is associated a considerable amount of brownish marl, especially at the top and bottom	2	0	51	6
	Limestone, with irregular surface, "cavernous," the cavities being occupied by brownish marl ...	1	6	53	0
	Great Oolite Limestones. Limestone	1	7	54	7
	Limestone, non-oolitic, cream-coloured but with a pinkish tinge (Spec. 19[2])	1	6	56	1

[1] *Proc. Cotteswold Nat. F.C.*, vol. xix, pt. 1, 1915, pp. 57-66. 'Excursion to Tetbury Waterworks,' *ibid.*, pp. 25-28 and pl. iv.

[2] See next page.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
	Limestone, yellowish, oolitic (except in places in the top portion), with more or less vertical veins of calcite	4	0	60	1
	Limestone, very similar to 19 ...	1	6	61	7
	Limestones, oolitic, massive-bedded. Some of the beds have irregular nether surfaces and tough brown clay (0 to 2 in. thick, between them. The beds are traversed by thin, more or less vertical veins of calcite: about 39 ft. 3 in. ... ... "Dagham Stone": about 9 in. Limestones, oolitic, massive-bedded: about 23 ft. 5 in. ...	63	5	125	0
	Limestone, grey, oolitic, with a yellowish zone (1 ft. 7 in.) between 2 ft. 9 in. and 4 ft. 4 in. down: 5 ft. 9 in. ... ... Limestone, grey. The upper 1 ft. 4 in. (spec. 23*b*[2]) is light grey and "sparry": the lower 11 in. (spec. 23*b*) more shelly, with some iron-pyrites: 2 ft. 3 in. ...	8	0	133	0
	Marl, black, shaly, with shell-fragments in pyritic condition, and at the base, numerous small crinoid-ossicles	1	0	134	0
'Passage Beds' (47 ft 6 in.)	Marl, grey, indurated, and veins of impure limestone (spec. 25*a*); crinoid-ossicles: 3 ft. 9 in. ... Marl, grey, unfossiliferous, with a 3 to 4-inch bed of very fine-grained sandy limestone in the middle: 1 ft. ... ... Limestone, grey, impure, and dark marl: 1 ft. 1 in. ... ... Marl, as before, with pyritised shell fragments in the lowest 9 in. (spec. 25*d*): 1 ft. 9 in. ... Limestone, grey, impure: 1 ft. 5 in. Marl, as before, 3 ft. 6 in. ...	12	6	146	6
	Limestone, very light grey, fine-grained, for the most part sandy to the touch. The topmost portion is of a darker grey, is bored by Lithophagi, and to the surface oysters are attached (spec. 2*b*). The upper 6 ft. 6 in. were drawn in one massive core, but the remainder was softer owing to the presence of marl; while in the bottom inch, shale, were numerous little pisolites ...	10	3	156	9

[2] The specimens referred to in brackets are to be seen in the Cheltenham Town Museum.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Fullers' Earth (79 ft. 6 in.)	Limestone, similar to the upper part of 26, with dark granules, drawn in one nice core (spec. 27)	5	3	162	0
	"Fullers' Earth," according to the foreman	3	0	165	0
	Marl, indurated, dark grey (1 ft.) passing down into light grey limestone, very similar to that of bed 27, but with dark granular (spec. 28)	7	6	172	6
	Marl, black, shaly, without fossils, except for a ½-inch layer of *Ostrea acuminata* J. Sow. ...	7	6	180	0
	Limestones, greyish, impure, with partings of shaly marl. The shaly marl, although dark, has a tinge of green. *Ostrea acuminata* J. Sow. common in the lower portions	1	6	181	6
	Ostrea Limestone	0	4	181	10
	Marl, dark, shaly; crinoid-ossicles abundant: about ...	1	1	182	11
	Limestone, impure, shelly; *Ostrea acuminata* J. Sow. common; crinoid-ossicles	1	1	184	0
	Marl, apparently unfossiliferous ...	3	6	187	6
	Limestone, impure, practically made up of specimens of *Ostrea acuminata* J. Sow.; 'pisolites' numerous in the middle portion.	3	2	190	8
	Ostrea Limestone: 4 to 9 in.: usually	0	8	191	4
	Limestone, similar to 35; *Pseudomonotis echinata* (J. Sow.). Small crinoid-ossicles very common in the lowest inch	5	2	196	6
	Marl, dark, shaly, relatively barren	4	0	200	6
	Limestone, similar to 37	4	6	205	0
	Ostrea Limestone (spec. 40) ...	0	7	205	7
	Marl, dark-grey, breaking up into small pieces on exposure to the weather, with irregular layers and lenticular pieces of a very fine-grained sandy limestone. Relatively barren, but with occasional crinoid-ossicles and specimens of *Ostrea acuminata* J. Sow.: about	12	5	218	0
	Marl, darker, but otherwise similar, with *Ostrea acuminata* more abundant in the lower portion and "pisolites" about ...	4	6	222	6
	Impure limestone	1	6	224	0
	Marl similar to 41*a*. In the lower 3 ft. shell-fragments (*Ostrea acuminata* J. Sow., *Volsella imbricata* (J. Sow), etc.) in a pyritised condition are numerous	28	0	252	0

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Inferior Oolite (135 ft.)	Rubbly Beds. Ragstone, rubbly' shelly ; *Terebratula globata* auctt. (common at the top and bottom) (spec. 44), *Rhynchonella, Entolium demission* (Phil.)	5	4	257	4
	White Oolite. Limestone, for the most part oolitic (spec. 45) ; *Clypeus* sp. (near the top), *Serpulae*	21	7	278	11
	Clypeus-Grit. Ragstone, rubbly, shelly ; *Serpulae* (abundant), *Terebratula globata* auctt., etc.	10	5	289	4
	Non-sequence. Upper Coral-bed and Dundry Freestone wanting				
	Upper Trigonia Grit. Ragstone, usual fossils. Lowest 3 in. rubbly and shaly	7	10	297	2
	Non-sequence. All the beds of the hemerae *niortensis* to *bradfordensis* (inclusive) wanting.				
	Lower Freestone. Top bed well bored by annelids. In the bottom 1 ft. 6 in. pentacrinoid ossicles are very abundant (spec. 48*b*.)	19	0	316	2
	Pea-Grit (spec. 49)	36	10	353	0
	Lower Limestone	34	0	387	0
	Non-sequence. Scissum Beds, etc., wanting.				
Upper Lias	Cephalopoda Bed (spec. 51). Maximum thickness	4	0	391	0
	Cotteswold Sands. Sandstone, hard, bored by annelids, and with a waterworn surface ...	0	3	391	3
	"Highly compressed blue loamy sand"	4	9	396	0
	"Comparatively sharp sand, light grey"	12	0	408	0
	Clayey sand	38	0	446	0

The following are particulars of the positions of the water-levels during boring operations :—18th October, 1915 : Borehole 214 ft. down. Until then the water had stood at the top of the borehole. 19th October, 1915 : Water-level suddenly dropped to a depth, from the surface, of 175 ft. Water stood at this depth for some time, but as the boring progressed it gradually rose to 162 ft. from the surface at which level it stood for "many weeks"—until 4th December. 4th December, 1915 : On piercing the bed of "comparatively sharp sand, light grey," the water rose to 154 ft. from the surface. 17th December, 1915 : When the boring was left off, at 446 ft. down the water-level was still standing at 154 ft. down.

No wells other than those at Warn's Brewery, Church Street, are now in use in the town. Previous to the 1892 scheme coming into operation the town derived its water from private wells from 70 to 125 ft. deep.

Well at the Tetbury Brewery.—The well at this brewery, formerly Messrs. N. and W. Cook's, but purchased by the Stroud Brewery Co., Ltd., in 1913, is 90 ft. deep, 6 ft. in diameter, in rock all the way down and steined for the first 12 ft. From the bottom of the well is a borehole 200 ft. deep and 6 in. in diameter. During a test in 1914, 85,000 gallons of water per 24 hours were

pumped continuously for three days. The water entered the well mainly through one noticeable fissure at the bottom. The brewery is situated on the Forest Marble, the clays of which hold up the water in the brewery pond.

Mr. Witchell's Brewery, Church Street.[1]—Woodward stated that the well at this brewery was "105 ft. deep, yielded about 2,000 gallons a day at a depth of 97 ft., but the supply at times became exhausted."

This brewery is adjoining and now part of Warn's Brewery, and the well referred to by Woodward is only used as a standby.

Tewkesbury—Maps: 216; [44]; (12 S.W., 19 N.W.)

The public supply is filtered Severn water supplied from the Pumping-Station of the Borough of Cheltenham Waterworks (42 ft. above O.D.) near The Mythe Bridge. As Severn water is only pumped during the periods when the Cheltenham town reservoirs are low, during non-pumping periods Tewkesbury receives its supply from the Cheltenham reservoirs. In 1921, 900 houses had a piped supply.

Houses without a piped supply obtain water from shallow wells with a depth usually of about 20 ft. The L.G.B. Return, 1915, states that the well-waters and springs in the Borough are "generally not suitable for drinking purposes" (p. 425).

Well at Tewkesbury Garage, High Street.—(Formerly the Tewkesbury Brewery Co.)—Boring made in 1893, by, and particulars communicated by, Messrs. LeGrand and Sutcliff. Surface-level.—42 ft. above O.D.

		Thickness Ft.
Dug well [? Gravel and red marl]	... ...	34
Boring :—		
Keuper Marl	Red marl	38
	[Red marl and] Gypsum ...	78

Lined with 5-inch tubes for 40 ft., commencing at 15 ft. from the surface. Water-level.—18 ft. from the surface. Yield.—1,200 gallons an hour.

"This boring has not been used for about nine years" (W. Ridler, 15th Nov., 1921).

Walter Ridler, Borough Surveyor, has furnished me with the following information, my own notes being given in parentheses:—The Mythe [on Lower Lias], piped supply. Tewkesbury Park [on Lower Lias], spring in use at Dog Kennels and in part piped supply. Park Farm [on Lower Lias], well. Southwick Park [house on Rhaetic], piped supply.

In addition to the spring at the Dog Kennels there is one at The Folly, close to the south boundary of the Borough and about 1,000 yds. west of the Odessa Inn, which is used by the cottagers at The Folly.

Westbury-on-Severn—Maps: 234; [43 S.E.]; (24 S.W., S.E., 32 N.W., N.E., S.W., S.E., 40 N.E.)

The district is strictly rural in character and the 400 houses in it are dependent on wells and springs; the majority on the former. No complaints of shortage have been received by the officials of the Council. H. E. W. Hook, the Sanitary Inspector, informs me that there are several springs at the extreme western end of the District from which several houses are supplied and although they are not strong springs they have not been known to fail. He states that there are 315 wells in the District, some serving three or four houses, but that it is difficult to obtain particulars as to their depths as the majority are covered over and have pumps affixed.

[1] Woodward, H. B., 'The Jurassic Rocks of Britain,' vol. iv (*Mem. Geol. Surv.*), 1894, p. 508.

In the village are 23 wells. Mr. Hook states that at his house, The Weighbridge, the well is 27 ft. deep. "I have a pipe from a pump which is under water 4 ft. During the whole of last summer [1921] the water never dropped so that the pump could not be used, although we were using many hundreds of gallons a day. The water is very hard, especially the temporary hardness."

Broughtons and Grove Farm obtain their main supply of drinking water from a spring on the eastern slope of Flaxley Park: the secondary supply from wells, the well at Broughtons being about 30 ft. deep and liable to fail and that at Grove Farm about 15 ft. deep. A ram pumps water from the stream which flows from Flaxley to Westbury to Broughtons for cleaning purposes, etc.

Northwood Green, Upper Ley, Frowens, etc., are satisfactorily supplied by wells some 15 to 50 ft. deep. At Grange Court Wagon Works the well was about 40 ft. deep.

The deepest well in the Urban District, so far as Mr. Hook is aware, is at Moys Hill, ¾ mile south by east of Westbury-on-Severn.

Chaxhill.—The district is mainly on Lower Lias. Several small but constant springs issue from the portion of the escarpment of the Rhaetic and basal Lower Lias beds which overlooks Walmore Common. The wells in this Lower Lias tract are from 10 to 40 ft. deep and yield on the whole a constant supply of good but hard water. Well water at Cleeve, however, occasionally "smells and tastes of sulphuretted hydrogen."

IV.—MUNICIPAL BOROUGH OF CHELTENHAM

Maps: 216, 217, 234, 235; [44]; (26 N.W., S.W., N.E., S.E., 27 N.W.).

Cheltenham originated on a 'sand-bed,' the geographical extent of which is represented on two geologically-coloured six-inch maps that have been published.[1] The Chelt hollowed out a depression in this sand-bed which it has filled up with a deposit of gravel, loam and peaty matter and overspread this and some of the sand with Alluvium. Subsequently the town extended on to the Lower Lias clay.

The sand-bed is composed mainly of yellow quartzose sand, but locally a considerable amount of gravel is associated with the sand.[2]

The wells situate in the sand-bed and subjected to pollution have all been closed within the last thirty years in favour of the town service: only a few houses near the borough boundary are dependent on wells for their potable supplies. These wells, if in Lower Lias, often yield a saline water. Saline water was met with in excavations for drains near the Mission Room, Hester's Way; in the well at Tichborne Cottage, between Hester's Way and Fiddler's Green; and in a well, 20 ft. deep, in the Lower Lias, sunk in 1922, on the south side of the Banfurlong Road and between it and Middle Reddings Farm. Another well, on the other hand, sunk at 100 yds. north-east of the last obtained a supply of satisfactory water from a seam of gravel in the Lias clay.

Cheltenham Waterworks.—Powers.—Cheltenham Water Acts, 1824, 1839, 1847, 1858, and 1865; Cheltenham Corporation Water Acts, 1878 and 1881; Cheltenham Orders, 1883, 1896, 1898, and 1905.

Limits.—The present area of supply is about 60 square miles, and comprises the Borough of Cheltenham (major part), Charlton Kings Urban District (part), parishes of Badgeworth (part), Leckhampton (part), Prestbury (part), Staverton (part), Swindon (part), Uckington, Up Hatherley (part) (Cheltenham Rural District); Ashchurch (part), Boddington (part), Deerhurst (part), Elmstone Hardwicke (part), and Leigh (part) (Tewkesbury R.D.), and furnishes supply in bulk to Tewkesbury Town Council and Tewkesbury R.D.C.

The Corporation has powers to supply in addition to the above—Shurdington (Cheltenham R.D.), Down Hatherley, Norton (Gloucester R.D.), Stoke Orchard, Tredington and Walton Cardiff (Tewkesbury R.D.).

Sources of Supply.—

1.—The well at the Sandford Road pumping-station in Sandford Mead (at which pumping was commenced in 1863) is in Chelt gravel, 24 ft. deep and 18 ft. in diameter, with a tunnel from the bottom running in the direction of the General Hospital. It is said to be capable of yielding 200,000 to 250,000 gallons a day.

2.—The Hewletts reservoirs (No. 1, 70,000 gallons; No. 2, 1,911,000 gallons; No. 3, 14,800,000 gallons; No. 4, 15,659,000 gallons) are fed by the Northfield Springs and drainage off 150 acres of ground. The Northfield Springs are thrown out by the Upper Lias clay (being fed with water that has percolated through the Inferior Oolite) and are caught in brick wells and conveyed to the reservoirs. Average daily yield.—287,000 gallons.

5.—The Leckhampton reservoir (open brick—opened 1824—having a capacity of 1,756,000 gallons) is supplied with water from the neighbourhood of the Marlstone (for there is a slight deposit of iron) and a hill-side gravel-bed, from which it is conveyed by pipes. Average daily yield 81,000 gallons.

4.—The Dowdeswell reservoirs are—(*a*) an impounding reservoir of 100,000,000 gallons capacity, and (*b*) a service or pure water reservoir of 80,000 gallons. They were opened in 1886. The impounding reservoir stores the

[1] *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 3, 1912, pl. xxxiii, and *idem.*, vol. xviii, pt. 2, 1913, pl. xvi.

[2] *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 3, 1912, pp. 311-315.

head-waters of the Chelt which are mainly derived from springs issuing from the base of the Cotteswold Sands and Inferior Oolite from which they are thrown out by the Upper Lias clay. J. S. Pickering, Borough Surveyor and Waterworks Engineer, informs me that the average yield of the springs in normal times is about 846,000 gallons and that this figure was the average for the three years ending Dec. 31st, 1920; but that the average for the year of drought, 1921, was 467,000 gallons—"the minimum yield during this period being only 142,000 gallons per 24 hours, the lowest ever recorded."

5.—Severn water is pumped[1]—after filtration—from Tewkesbury, a distance of about eight miles. The Corporation have power to take 500,000 cubic feet per day, but Severn water is only pumped during dry periods, and on an average only a third of the quantity permitted to be taken is required.

Mr. Pickering points out[2] that owing to the varied nature of the rocks in the Severn drainage area the composition of the river water varies considerably at different parts of the year. At times it is very turbid, owing to the bulk of the water coming off the Keuper Marl, and it is frequently of a brown colour from peat and decaying matter in the upper reaches. The filter beds are rapid pre-filters of the gravity type, capable of dealing with at least a million gallons in 24 hours, and filters of the ordinary type.

The average daily quantity of water supplied by the Cheltenham Waterworks is 1,474,715 gallons, and 90,052 gallons in bulk. The supply is constant and the pressure sufficient.

The quality of the water is generally satisfactory. Hardness: (1) 20° to 25° (Clark's); (2) 14°; (3) 14°; (4) 16°; (5) 11°, and there is no action on lead. Analyses, p. 253.

Mr. Pickering has written[3]:—"The undertaking was established by a water company in 1824, their supply works comprising the reservoirs at Hewletts and Leckhampton. In 1865 the company obtained an Act for supplying Tewkesbury, and for this purpose a small pumping station was erected on the Severn in 1869. An attempt was made at that time to supply Cheltenham from the same source, but failed owing to the opposition to a river supply. The proposal was revived by the company a few years later, but was again strenuously opposed, the Cheltenham authorities suggesting an alternative scheme for an impounding reservoir at Dowdeswell. The company being unwilling to entertain this, and the objection to the Severn supply being so strong, it was ultimately arranged to transfer the undertaking to the Corporation. The purchase was made in 1878, and in 1886 the Dowdeswell Reservoir and filtration works were brought into use.

"This new source of supply proved to be inadequate to meet the growing requirements of the district, and there appeared to be no alternative but to introduce Severn water. Accordingly, in 1900, a new pumping engine was erected at Tewkesbury, and in order to appease the opposition, the size of the pumping main was limited to 9 in. in diameter. This small pumping main proving insufficient, a second main 12 in. diameter was laid three years later. Since the author's appointment nine years ago, additional pumping and filtering plant has been installed at Tewkesbury, and at the present time the town depends upon the Severn for about a third of its water supply.

"The various sources and levels make the distribution somewhat complicated and difficult. The ordnance-level in the centre of the town is about 195 ft. The top water-level at Hewlett's Reservoir is 408 ft., at Dowdeswell pure-water tank 353 ft., at Leckhampton Reservoir, 380 ft., and the level at the Tewkesbury Pumping Station is 42 ft. above O.D."

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[1] The Lower Tower on the Mythe Tute is now (July, 1922) in disuse but is being brought into commission again for cleaning the sand filters. The Upper Tower is at a higher elevation for supplying the higher parts of the district (as well as the lower) not before supplied by the Lower Tower.

[2] *Trans. Inst. Water Eng.*, vol. xvii, 1912, p. 71.

[3] *Trans. Inst. Water Eng.*, vol. xvii, 1912, pp. 69-70.

In 1896 the water in the Dowdeswell Reservoir assumed a deep red-brown colour and remained so for about six weeks with apparently no harm to the public health. It was ascertained by Dr. J. H. Garrett, the Medical Officer of Health, that it was caused by a deposition of ferric hydroxide on the membranes of myriads of individuals of the iron-bacterian *Crenothrix polyspora* (Cohn).[1] The water supplies of several continental towns have been visited in this way, but in England so far as is known this Cheltenham one is the only instance. Dr. Garrett says that there are some oozings of iron-stained water at several places in the banks of the reservoir and that in 1896, when the visitation occurred, the reservoir was never filled to overflowing as is generally the case and the water contained was consequently less well aerated, and more concentrated in local constituents than usual.

" Water containing a trace of iron is liable to be affected by the microscopic filamentous alga *Crenothrix*, which contains no chlorophyll, and is capable of growing in the dark, as within water mains for example, and the thick coating sometimes found deposited upon the inner surface of water-pipes may consist of this organism together with carbonate of lime and iron rust."[2]

Well at The Cheltenham Brewery, High Street.—Particulars communicated by G. P. Hopcraft, General Manager.

Surface-level.—About 191 ft. above O.D. Deposit.—Wholly in the " sand-bed," resting on Lower Lias clay. Total depth of well.—35 ft. Depth of water in well.—13 ft. (3rd Jan., 1922). Average daily quantity of water used.—27,000 gallons (estimated). Owing to the drought the rest-level of the water was low in 1921. Analysis p. 252.

Wells at the College Baths (College Baths Road). Five wells in the " sand-bed " supply the Baths, but only four are usually drawn on.

Surface-level.—About 212·3 ft. above O.D. Deposit.—" Sand-bed " resting on Lower Lias clay. Average depth.—25 ft. Diameter.—6 ft. Yield.—On an average 150,000 gallons a week.

Well at The Model Laundry, Up Hatherley. This laundry uses Cheltenham Corporation water, 30,000 gallons per week of five days.

In 1896 the Directors wished to obtain a private supply. Two dowsers were called in so that separate results could be obtained and compared. The dowsers' advice was not accepted because it was " feared the water would be unsuitable." The fears were probably well grounded.[3]

CHELTENHAM WATERS

Wells sunk in the Lower Lias clay almost anywhere in Gloucestershire may yield a saline water, and not infrequently spring water issuing from sand and gravel deposits resting on the clay is similarly impregnated. The Cheltenham saline waters originate in the Lower Lias,[4] and do not, as was once widely held, rise through fissures in the Lower Lias from the underlying Keuper Marl.[5] The true Chalybeate Springs at Cheltenham appear to originate in Chelt-side Superficial Deposits with which there is an admixture of peaty matter.

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[1] See David Ellis, " Outlines of Bacteriology," 1909, p. 152.

[2] *Trans. Inst. Water Eng.*, vol. xvii, 1912, p. 175 ; see also *Public Health*, Oct., 1896.

[3] See Prof. [Sir] W. F. Barrett, *Proc. Soc. Psychical Res.*, vol. xv, 1901, pp. 187-191.

[4] Some of this clay used in brickmaking is strongly impregnated with salt which sometimes causes masses of bricks to be fused together in burning.

[5] See Murchison, R. I., ' Geology of Cheltenham,' 1834, pp. 33-351 ; *Proc. Geol. Soc.* vol. i, 1826-1833, p. 390 ; ' Silurian System,' 4to London, 1839, pp. 34-36 ; E. Hull, ' The Geology of the Country around Cheltenham," (*Mem. Geol. Surv.*), 1857, p. 84 ; H. B. Woodward, ' The Jurassic Rocks of Britain,' vol. iii (*Mem. Geol. Surv.*), 1893, pp. 323-325.

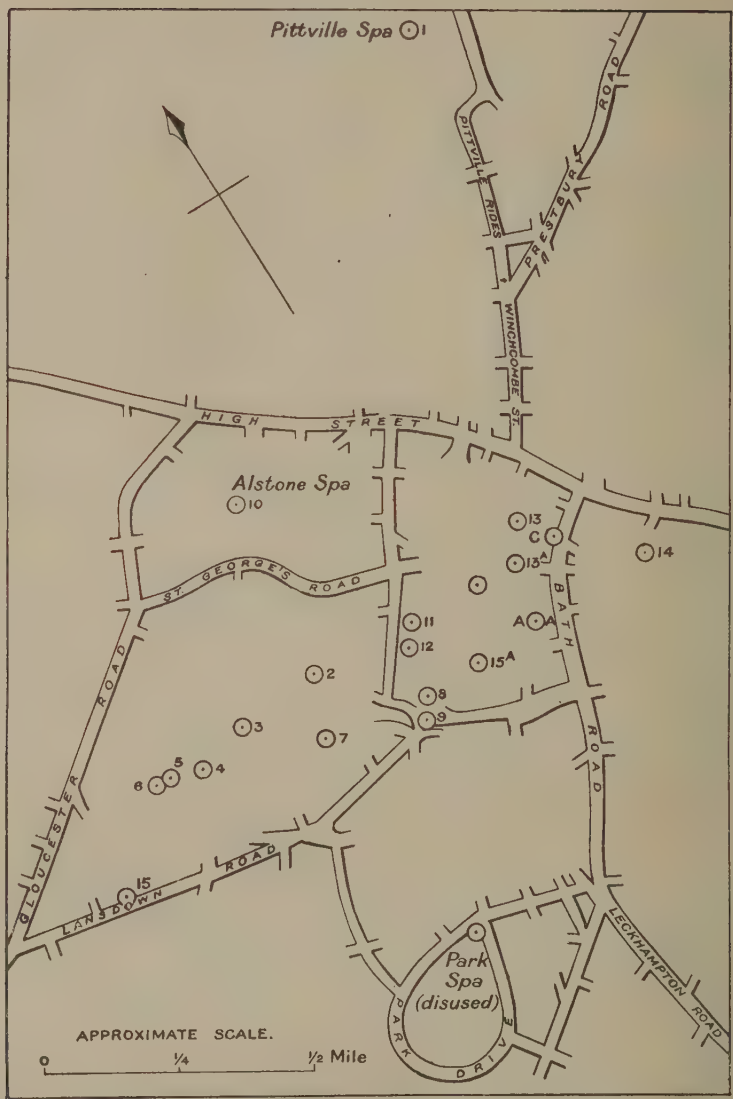

FIG. 7.—*Map showing the positions of the Mineral 'Springs' at Cheltenham.*

Attention, it is stated, was first directed to the Cheltenham Waters on account of the daily visits of pigeons to feed on salt deposited by a spring that oozed from "a strong thick bluish clay or mould under the sandy surface of the soil, which after spreading itself for a few yards again disappeared . . ." and it was "remarked that when other springs were fast bound by the frost this continued in a fluid state."[1]

[1] *New Guide to Cheltenham*, G. A. Williams, 1820, pp. 20-23, 66, 67.

This spring was on Mr. Mason's ground, and for about two years after its discovery remained open and the people of the town and neighbourhood drank of it. In 1718 it was railed in, locked up, and a little shed erected over it.

The first analysis was made by Drs. Greville and Baird, and the water was sold as a medicine until 1721, when the 'well' was let to a Mr. Spencer at £61 per annum.

In 1738 Capt. Henry Skillicorne not only erected a pump-room " . . . on the west side for the drinkers . . . , but protected the spring from all extraneous matter."[1]

About 58 gallons of the water were drawn from this, the Original, Old, or Royal Well,[2] daily. In 1808 the well was enlarged.

In 1788 George III visited Cheltenham to take the waters, and stayed at Bayshill House. A well was sunk to supply the house with 'fresh spring water,' but it proved to be saline like that from the Original Well. The well became known as 'the King's Well'[3]; but in 1802 it was in a state of decay.[4]

New wells were subsequently sunk in various parts of the town, and by 1814 thirty-four wells and springs were in use either for drinking purposes at the pump rooms or for the manufacture of Salts. This number was afterwards increased to more than 50, and a copious literature devoted to the remedial properties of the waters testify to their popularity. Numerous visitors were attracted to the town, the population of which was increased from 1,500 in 1666 to 31,385 in 1841, and the number of visitors from 374 in 1780 to 1,200 in 1836.

The use of many of the pump-rooms was, however, gradually discontinued, and the only springs now in use are those indicated in the list, p. 216. In the Cheltenham Guide (c. 1825), p. 34, it is stated that "'the King's Well' and various others have sunk into neglect." Most of the buildings have fallen into decay and the sites of many of them are unknown.

Sherborne Spa (opened in 1818) stood on the site of the Queen's Hotel (which was built in 1838), and was supplied from a spring, now disused, between that building and the present Montpellier Gardens.

The water for Park Spa was drawn from a well in the Lower Lias under a small pump-room, now the house called "Gonia," that was erected by a Mr. Billings. The water was said to differ considerably from that of the other springs (analysis, p. 215).

The use of the Rotunda as a Spa was discontinued some 45 years ago, and the supply was diverted to the Chalet in Montpellier Gardens, on the opposite side of Montpellier Walk, where waters are still dispensed. The Montpellier Spa was opened in May, 1808. The original pump-room proved too small and the Rotunda was added to it and became the pump room in 1826. One of the waters dispensed at the Rotunda Spa was said to have been a "sulphuretted saline," and was obtained from a well in the Lower Lias, 80 ft. deep, under the building. Other kinds of medicinal waters were conveyed by pipes from wells not yet clearly identified.

In 1815 medicinal waters were encountered in a well known as the "Essex Well" in a field, the property of Lord Essex, opposite the "Montpellier Wells on the west side of the Badgeworth Road."

In the "New Guide to Cheltenham" (1820), p. 33, there is an account of some springs that rose immediately underneath a building then known as "Hygeia House" (now the "Central Spa Nursing Home") in Vittoria Walk (A on the map, fig. 7, p. 208), then owned by H. Thompson, the proprietor of the Laboratory in Bath Road. These springs yielded "Carbonated Steel

[1] Ruff, H., 'This History of Cheltenham,' 1803, pp. 65, 66.

[2] For site see map, fig. 7, No. 11.

[3] On Dr. Jamieson's map in "A Treatise of the Cheltenham Waters" (1814), this well is incorrectly marked as the Royal Well, a name that had been given previously to the Original or Old Well.

[4] The water that supplied "the King's Well" is probably connected with the well at the back of 22, Lansdown Terrace, marked "No. 2" on the Corporation map, and on that on p. 208.

water, rising out of a black ferruginous mould a few yards from the house; Chalybeated Weak Saline rising out of blue clay in the area of the house; and weak Sulphurated Saline rising out of blue clay immediately under the house." The positions of these springs are still visible.

The waters from the Hygeia House springs together with those at Bescroft Meadow and Octagon Turret were also used in making Salts. "Although the different saline wells supply a great abundance for drinking and bottling they do not produce a sufficient quantity for making Salts upon a large scale, and new wells have in consequence been dug at the bottom of Bayshill for that purpose." The exact positions of Bescroft Meadow and Octagon Turret are not known, but were probably between the Bath Road Laboratory and Hygeia House.

The first true chalybeate spring to be discovered in Cheltenham became known as The 'New' Chalybeate Well at "Barrett's Chalybeate Spa." It is described in "Wood's Cheltenham Guide" (c. 1820), p. 31, as situated in a meadow belonging to Mr. Barrett about 200 yds. from the Flour Mill (Barrett's) and nearly the same distance from the upper end of the town. Its site would appear to be at or near James's Works by the side of the Chelt and College Road (14 on the map, fig. 7, p. 208). There is little doubt that the original spring issued from Chelt-side gravel.

Dr. Fothergill mentions the spring in his Treatise of 1778 and it had certainly been held useful in connexion with eye affections for many years previous to 1802, when it was found to be but a small branch of "a very copious spring." By making a well some 4 ft. deep a yield of 130 gallons an hour was obtained. Mr. Barrett, the proprietor, had a "commodious room" built for the convenience of those drinking the water.

In H. Ruff's "History of Cheltenham" (1803, pp. 105-106) it is stated:—"From an analysis, it appears to contain a larger proportion of iron than is common to waters of this class; and the combination of it with carbonic acid gas is so complete, that it will retain its properties when closely corked in a bottle which is quite full, for several months. . . . When taken from the bottom of the well, it contains about five times as much iron as the celebrated water of Tunbridge; and about one-fifth more than the Pouhon spring at Spa."

Fowler's Chalybeate Spa referred to in Bettison's History of Cheltenham (1825), p. 62, was "at the bottom of Cambray Street" and is probably the "Cambray Chalybeate Spa" described in the 'Cheltenham Guide' of 1818, p. 105, as situated "at the end of Cambray Parade." In 'Williams' New Guide to Cheltenham' (c. 1825), p. 35, there is a view of this Spa in which the names 'Cambray Spa' and 'Chalybeate Lodge' appear on the front of the house, which is still in existence and is known as "Woodland Villa,' Rodney Road. A slight depression near the southern end of the house marks the position of the 'spring,' the use of which has long been discontinued. This chalybeate water (analysis, p. 215) also occurred in Chelt-side gravel, with associated clayey matter.[1]

The position of a "Carbonated Chalybeate Well, . . . the property of Mr. Jones . . . on the northern bank of the Chelt about 250 yds. from High Street,"—described in 'Wood's Cheltenham Guide' (c. 1820), p. 35—has not been identified.

The Cheltenham Mineral Waters in use at the present time are the Saline Waters and the wells whence they are obtained, with the exception of that at Alstone Spa which is owned by G. Ballinger, are the property of the Corporation. The Chalybeate Waters are not now used and are in private possession.

The Saline Waters chiefly in use are:—(1) The Field or Twin Salt Saline; (2) The Lansdown or Sodium Sulphate Saline; (3) The Pittville or Alkaline Saline; (4) The Chadnor or Magnesium and Calcium Saline.

[1] A boring put down between Cambray House and the Chelt proved about 20 ft. of this gravel, etc., resting on Lower Lias clay and the rest-level of the water to be 9 ft. down. *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 3, 1912, p. 317.

These waters are of three varieties, or rather their several constituents are present in as many different proportions. They are grouped as :—(1) Strong Saline (Pittville and Montpellier), chloride of sodium preponderating ; (2) Bitter Saline (Cottage Spring), Glauber's Salt and sulphate of magnesia, Epsom Salts being the leading ingredients ; and (3) Alkaline muriatic (Pittville) both chloride of sodium and sulphate of soda existing in notable quantities and their alkalinity being determined by the presence of the bicarbonates of sodium and magnesium.

The waters may be obtained at The Central Spa (Town Hall), the Chalet in Montpellier Gardens and at Pittville.

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Analyses of Cheltenham Waters

Fieldholme Well.—Eldorado Road. Well in Lower Lias.

The Magnesia Sulphate Saline

	Grains per gallon
Magnesium sulphate	141·750
Sodium sulphate	127·834
Sodium chloride	36·974
Sodium bromide	traces
Potassium sulphate	5·306
Potassium nitrate	1·841
Lithium chloride	traces
Calcium carbonate	40·810
Calcium sulphate	45·640
Manganous sulphate	traces
Ferric and Aluminic oxides	·126
Silica	·840
Organic matter	traces

This water, variously described as the "Twin Salt Saline" and "Magnesia Sulphate Saline," is a valuable water and unique in that it contains nearly equal parts of magnesium sulphate and sodium sulphate. Evaporated to a given density it is sold bottled as 'Chelspa'—The Cheltenham Natural Aperient Water.

Lansdown Terrace Well.—At the back of 22, Lansdown Terrace. Well in Lower Lias.

Soda Sulphate Saline

	Grains per gallon
Sodium chloride	391·710
Sodium bromide	0·001
Sodium iodide	0·021
Sodium sulphate	155·720
Sodium silicate	1·763
Potassium sulphate	9·990
Lithium chloride	traces
Calcium carbonate	27·200
Calcium sulphate	2·447
Magnesium carbonate	14·115
Magnesium sulphate	22·667
Manganous carbonate	traces
Ferrous carbonate	0·021
Aluminium phosphate	traces
Organic matter	traces

The chief ingredients of this water are sulphate and chloride of sodium, but also small quantities of a variety of compounds. As compared with the Alkaline Waters this is less alkaline and solvent. This water closely resembles the Kissingen Waters, and is said to be the water *par excellence* for anaemic dyspeptics.

Prof. Thorpe in his Report to the Town Improvement Committee of the Cheltenham Town Council in 1893 stated :—This water contains about 625 grains per gallon of saline matter, more than half of which consists of common salt, and about a fourth of sodium sulphate (Glauber's Salts). The quantities

of bromides and iodides are small, and only spectroscopic traces of lithia could be detected. The amount of iron is about the same as in the Cottage Well.

Pittville Wells.—Pittville Gardens. Wells, the deepest 102 ft. (7 ft. in diameter at the top, 2 ft. 6 in. at the bottom), in Lower Lias.

Bicarbonate of Soda Saline

	Grains per gallon
Sodium bicarbonate	29·493
Sodium sulphate	148·435
Sodium chloride	310·985
Sodium bromide	0·106
Sodium iodide	0·056
Sodium silicate	1·120
Potassium sulphate	2·345
Lithium chloride	traces
Calcium carbonate	13·724
Calcium phosphate	traces
Magnesium carbonate	12·541
Manganous carbonate	traces
Ferrous carbonate	0·134
Aluminium phosphate	traces
Ammonium bicarbonate	0·071
Organic matter	traces

This water possesses so much sodium chloride with relatively small quantities of other salts that it is specially suitable for bathing purposes. A slight degree of concentration is necessary as the water itself produces only ·75 per cent. solution. It is noteworthy as being the only alkaline natural water in Great Britain. In analyses it greatly resembles Carlsbad or Marienbad Water, more particularly the latter as it is a cold water. It contains chiefly chloride and sulphate of soda, along with bicarbonate of sodium, the latter salt giving it a decided alkalinity equal to about five grains of bicarbonate of soda in the pint.

Prof. Thorpe reported :—Soda Saline Waters Nos. 2, 3 and 4 (Pittville Wells, I, II, III),—The Pittville Wells, Nos. I and III, bear a close resemblance to each other, the first contains about 662 grains per gallon of saline matter, the second about 644 grains, by far the largest constituent in each case being common salt. Both the waters contain notable quantities of bromides and iodides, and each contains sodium bicarbonate to the extent of rather more than 30 grains per gallon, which gives to the water on standing a marked alkaline reaction. The amount of sodium sulphate is, in round numbers, rather more than 100 grains per gallon. In both the amount of lithia is so minute that it can be detected only by the spectroscope. The proportion of ferrous carbonate is distinctly higher than in the Magnesia saline waters, but is still insufficient to allow us to regard the Pittville springs as chalybeate. The general character of these waters as represented by the samples sent to me, although not absolutely identical, is still so very similar that, for all practical purposes, they may be regarded as substantially of the same composition. The waters in all probability are derived from the same gathering grounds and the difference in their composition are not greater than may be ascribed to accidental variations, such as all mineral waters are liable to exhibit.

Chadnor Villa Well.—Indicated on the six-inch map, 26 N.E., by the letter 'W' near the junction of Well Place with Christ Church Road. Well, about 70 ft. deep, in Lower Lias.

Magnesium and Calcium Saline Water

	Grains per gallon
Sodium chloride	27·980
Sodium bromide	0·015
Sodium iodide	0·037
Sodium sulphate	60·893
Sodium silicate	1·469
Potassium sulphate	4·779
Lithium chloride	traces
Calcium carbonate	36·372
Calcium sulphate	63·460
Magnesium sulphate	117·659
Manganous carbonate	0·023
Ferrous carbonate	0·038
Aluminium phosphate	0·011
Ammonium nitrate	0·018
Organic matter	traces

This water contains a large quantity of sulphate of magnesium and a considerable amount of carbonate and sulphate of calcium, which salts are valuable diuretics.

Prof. T. E. Thorpe reported:—This water contains about 313 grains of saline matter in the gallon, the principal constituents of which are magnesium sulphate (Epsom Salts) to the extent of about 118 grains, and sodium sulphate (Glauber's Salts) to the extent of about 61 grains per gallon. It contains relatively little sodium chloride, and the amount of ferrous carbonate is too small for the water to be regarded as chalybeate. The proportion of bromides and iodides is also very small. The amount of lithia is too minute to be quantitatively estimated.

The water has probably considerable therapeutic value on account of the relatively large proportion of the aperient salts it contains.

The Cottage or Fulshaw Lodge Well.—Fulshaw Lodge, Christ Church Road. Well in Lower Lias.

Prof. T. E. Thorpe's general remarks concerning the water from this well are:—Magnesia Saline Water No. 2 (Cottage Well). This water contains about 390 grains of saline matter per gallon. about one-third of which consists of Epsom Salts, and rather more than a fourth of which consists of sodium sulphate, together with notable quantities of gypsum, chalk and common salt.

It contains only minute quantities of ferrous carbonate, much too small in amount for it to be classed as chalybeate water. Bromides and iodides are absent, and the amount of lithium is too small to be quantitatively determined. This water has considerable resemblance to that of Chadnor Villa, and the same remarks apply as to its therapeutic value.

Park Spa.—Well in Lower Lias. Analysis by Messrs. Heathfield and Burgess.

	Grains per gallon
Sulphate of soda	77·00
,, lime	86·00
,, magnesia	66·00
Chloride of sodium	602·00
[1]Carbonate of lime	20·00
,, magnesia	8·00
,, soda	trace
[1]Oxide of iron	·30
Organic matter, waste, etc.	·70

Alstone Spa.—Analysis by Lawrence Briant, F.C.S.

	Grains per gallon
Total solid residue	345·04
Lime	23·91
Magnesia	48·80
Soda	93·47
Potash	2·15
Sulphuric acid	8·16
Nitric acid	Nil
Nitrous acid	Nil
Chlorine	210·00
Bromine	traces
Iodine	traces
Iron	0·013
Silica	0·70

Note of Analyst.—This water contains considerable amounts of chloride of sodium, chloride of magnesium, and chloride of calcium, together with a smaller quantity of sulphate of lime, also distinct traces of iodides and bare traces of bromides.

Cambray Spa.—From well 66 ft. deep probably through Chelt-side deposits into Lower Lias. Analysis by Michael Faraday, F.R.S.

Saline Water (Salts in dry state)

	Grains per pint
Muriate of soda	51·06
,, lime	8·60
,, magnesia	a trace
Sulphate of soda	17·04
Carbonate of lime	·80
,, iron	a mere trace

Cambray Spa.—Well in Chelt-side gravel, etc., in garden of the house now called 'Woodland Villa,' Rodney Road. See p. 210. Analysis by Frederick Accum, F.L.S.

The Chalybeate Water

	Grains per gallon
Carbonate of iron	7·65
Muriates of lime and magnesia	15·50
Muriate and Sulphate of Soda	24·00
Sulphate of lime	9·00
Carbonate of magnesia and lime	8·95

This water was almost clear when first drawn but darkened on exposure.

[1] These substances are held in solution by free carbonic acid.

Cheltenham Spa.—Particulars of Medicinal Wells and Spring. (Views of some of the Old Spa buildings are exhibited in the Cheltenham Municipal Museum.)

No. on map fig. 7 page 208	Situation	Name, and, when known, date of opening.	In use *a*. Not in use *b*.
1	Pittville Gardens ...	*Pittville Pump Room. 1830	*a*
2	Back of 22, Lansdown Terrace	*Lansdown Terrace Well. Formerly connected with the King's Well.	*a*
3	Well Place near Christchurch Road	*Chadnor Villa Well ...	*a*
4	Christchurch Road ...	*Fulshaw Lodge Well ...	*a*
5	Near Eldorado Road ...	*St. Florence Well	*a*
6	Eldorado Road	*Fieldholme Well	*a*
7	Lansdown Crescent ...		*b*†
8	Montpellier Walk ...	Montpellier, later Rotunda Spa. 1808	*b*
9	Montpellier Terrace ...	Marlborough House Well ...	*b*
10	"Brooklyn," Great Western Road	Alstone Spa. 1809. Privately owned	*a*
11	Fauconberg Road ...	Royal Well. Original Spa. 1718	*b*†
12	Between Bayshill Road and Montpellier Street	Orchard Well	*b*†
13	Woodland Villa, Rodney Road	(Formerly connected with Cambray Spa). 1804	*b*
13a	Corner of Oriel and Rodney Roads	Cambray Spa. 1783 ...	*b*
14	College Road	Original Chalybeate Spa ...	*b*†
15	Lansdown Lodge, Lansdown Road		*b*†
15a	Montpelier Gardens near Montpellier Spa Road	*(Well)	*b*

*Owned by Corporation †Approximate position only known.

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V.—COUNTY BOROUGH SUPPLIES

Gloucester—Maps : 234 ; [43 S.E., 44] ; (25 S.W., S.E., 33 N.W., N.E.)

Gloucester is supplied by the Gloucester Corporation Waterworks, and the late E. W. A. Carter, the City Surveyor and Waterworks Engineer, informed me that so far as he knew the only wells still in use in the City for domestic purposes were :—1. Westgate Street, opposite the Shire Hall, at the shop and premises of Mr. Weeks Best ; 2.—Asylum Lane, at the rear of London Road, two cottages which are used in connexion with Wotton House, Horton Road ; 3.—At Saintbridge, on the Painswick Road, where there are one or two wells which supply five cottages ; 4.—At 189, High Street, near Tredworth Road ; 5.—At 129, Southgate Street (Miss Cooper's).

Gloucester Corporation Waterworks.—Powers.—Gloucester Waterworks Act, 1855 ; Gloucester Corporation Acts, 1894 to 1911.

Supplies Gloucester City Boundary and parts of parishes of Badgeworth, Barnwood, Brockworth, Churchdown, Hempsted, Highnam Over and Linton, Hucclecote, Longford, Matson, Upton St. Leonards, Wotton St. Mary Without, Wotton Vill, and furnishes supply in bulk to Newent R.D.C.

Limits.—The above and Great Witcombe, Little Witcombe, Tuffley, Sandhurst, Twigworth, and to premises within a mile of the pumping and gravitation mains of the Oxenhall and Ketford Works.

Sources of supply.—

1. Gathering ground of 260 acres at Robins' Wood Hill ;[1]
2. ,, ,, 1,500 ,, Witcombe ;
3. Well in New Red Sandstone, Oxenhall, near Newent ;
4. Boreholes ,, ,, Ketford, Pauntley.

The average daily quantity of water available from each source is respectively :—1. 70,000 gallons ; 2. 600,000 gallons ; 3. 750,000 gallons ; and 4. 840,000 gallons.

Works.—Water from sources (1) and (2) filtered (pressure filters).

Storage Reservoirs :—

Robins' Wood Hill : (*a*) 9,000,000 gallons, (*b*) 1,000,000 gallons.

Witcombe : (*a*) 64,000,000 gallons, (*b*) 23,000,000 gallons, (*c*) 33,000,000 gallons.

Service Reservoirs :—

Madam's Wood, Newent : (*a*) 600,000 gallons, (*b*) 1,200,000 gallons. Pressure is sufficient.

Quality of Water :—

Hardness :	(1)	Permanent	7	degrees, total	20	degrees
	(2)	,,	3·8	,, ,,	13·6	,,
	(3)	,,	9·23	,, ,,	28·74	,,
	(4)	,,	8·8	,, ,,	22·4	,,

No action on lead.[2]

Further remarks.—

1.—The reservoirs at Robins' Wood Hill were constructed by the Gloucester Water Company in 1837-38, and were purchased from the Company by the Corporation under the Gloucester Water Act of 1855 for £18,500. Part of the gathering ground for the supply is in a depression in the side of the hill which extends and narrows upwards between two shoulders of Marlstone, terminating at the foot of the slope where the Cotteswold Sands begin ; but a considerable quantity of water is collected and brought round the contours

[1] Use recently discontinued.

[2] I am indebted to the late E. W. A. Carter for the above particulars.

of the hill in pipes and conduits to the reservoirs. Most of the water is derived from two horizons, (1) the base of the Sandy Beds of the Middle Lias, and (2) the base of the Cotteswold Sands.

2.—The reservoirs at Witcombe were constructed under the powers of the 1855 Act. The formal opening of the reservoirs was on Sept. 20th, 1860, when the water was turned in from the upper to the lower reservoir, but the works were not actually completed until 1863. The third reservoir (*c*) was commenced in 1868 and finished in 1870.

R. Read wrote in 1912[1] :—". . . Mr. Bateman, C.E., having recommended the Witcombe scheme as the best one available, the works were proceeded with and opened in 1863.

"The gathering ground at Witcombe which he selected is 1,500 acres in extent forming an escarpment [better, a bay-like hollow in the western face] of the Cotswold Hills, about 5 miles eastward of the City. The top of the escarpment is about 950 feet above sea-level, and comprises (in descending order) a small bed of the Great Oolite, Fullers' Earth, Inferior Oolite, Midford [Cotteswold] Sands, Upper Lias Clay, Marlstone, and Lower Lias Clay. Unfortunately, the dip of the strata is at an angle of from 7 to 9 degrees, away from the face of the escarpment towards the Thames [and Frome] Valley in a south-easterly direction, therefore the amount of spring water (which passes down through the Inferior Oolite and is thrown out by the Upper Lias Clay on the face of the escarpment at about 600 ft. above sea-level), is very limited, varying from 120 to 150 thousand gallons per day. The escarpment is, however, very steep, in some places near the top being at a slope of 1 in 3, and therefore a large quantity of water (averaging about one-third of the rainfall, and even in the very driest years one-sixth of the rainfall) runs off the surface."

It is clear that all the water that could be utilised is efficiently collected and is conveyed into the upper reservoir (*a*) from which it is decanted into the other two. In the opinion of W. Fox the storage "is practically sufficient for the gathering ground from which the present supply is derived."

Ten mechanical filters, made by Messrs. Bell Bros., of Manchester, were installed in 1901 to deal with the trouble from weeds growing in the Witcombe reservoirs and have proved very effective.

Experiments were also made to stop the growth of the weeds by treating the waters with copper sulphate and Mr. Read said that "undoubtedly the treatment is beneficial to the water and relieves the filters very considerably" in getting rid of the obnoxious taste and smell.[2]

3.—Well in New Red Sandstone, Oxenhall, near Newent. See Oxenhall, p. 130.

4.—Boreholes in New Red Sandstone, Ketford, in the parish of Pauntley. See Pauntley, p. 133.

History of Water Supply.—The history of the water supply of Gloucester until 1838 has been written by Roland Austin[3].

In 1855 an Act for the better water supply of the City (19 Vic., Cap. 89) authorized the purchase of the Robins' Wood Hill works of the Gloucester Water Company and the construction of the reservoirs at Witcombe.

In 1874-75 the City was extended, the whole of the Barton district was taken in, and there was a prospect of an early deficiency. Mr. Read gave a trial to the Deacon Meter in 1880 and as, after modifications, it proved satisfactory, the system was adopted throughout the City, which was mapped out into twenty districts.

In 1880 J. F. Bateman was called in to report on the best means of obtaining an additional supply, and in the August of that year proposed "to tunnel

[1] *Trans. Inst. Water Eng.*, vol. xvii, 1912, p. 159.
[2] *Ibid.*, p. 167. See also G. Embrey, *ibid.*, pp. 168-171.
[3] *Proc. Cotteswold Nat. F. C.*, vol. xvii, pt. 3, 1912, pp. 353-563.

from the streams flowing past Witcombe Hall in an easterly direction until the tunnel, which would be commenced in the Lias, touched the base of the Oolites where it rests upon the impervious strata of the Lias. . . . And from the end of this tunnel drifts or galleries should be driven to cut the faults indicated on the geological map of the district, where it is reasonable to expect a considerable increase of water."

By this means, Bateman says :—" I think it possible, perhaps probable, that 200,000 to 300,000 gallons of water per day may be obtained from the Oolite" (see p. 96).

The scheme did not meet with general approval and it was vetoed by the Local Government Board.

The Deacon System made for economy in the use of water, but in 1890 it was evident that a new source of supply was necessary. William Fox, after considering several schemes recommended the Newent Scheme, namely, to pump from the sandstone near Newent. This was discussed with Prof. Charles Lapworth and Robert Etheridge, and submitted to James Mansergh, who endorsed Mr. Fox's recommendations. This scheme was accordingly adopted, and in 1895 the Corporation obtained Parliamentary sanction (58 Vic. ch. xci) to construct a well and a pumping-station and other works in the parish of Oxenhall, and a reservoir at Madam's Wood in the parish of Newent.

Although a very large supply of water is obtained from the Oxenhall Well, in order to make provision for the future requirements of the City, and ensure that as the population increases, there should be a corresponding supply, further powers were sought and obtained (2 Geo. V. ch. xcii) in 1911, for the construction of additional works at Ketford, in the parish of Pauntley.

1.—*Boring at City Brewery* (*Messrs. Searle & Co.*).—Made (1875) and communicated by Messrs. LeGrand and Sutcliff.

		Depth Ft.
Lower Lias.	Blue clay	49½

2.—*Boring at Messrs. Moreland and Sons' Factory.*[1]—Bristol Road near the Gloucester Wagon Works.

		Depth Ft.
Lower Lias	Clay " all the way," very little limestone was encountered	400-450

The boring commenced in clay of late *oxynoti, raricostati,* or early *armati* hemera. Philip Moreland informed me that the required and guaranteed quantity [of water] per hour was not obtained.

3.—*Boring at Robertson and Co.'s Brewery, Westgate Street.*[2]—(Now the milk depot of the Gloucester Farmers Ltd.).—Made in 1883 by R. B. Paten.

		Thickness Ft.	In.
Dug well :—			
Made ground	... ...	9	0
Superficial Deposits	Gravel with sand at base. A little water ...	6	0
Lower Lias	Lias with layers of stone and shale	334	7½
	Total	349	7½

[1] Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xviii, 1914, pt. 3, p. 250.

[2] Lucy, W. C., *Proc. Cotteswold Nat. F. C.*, vol. viii, 1885, pp. 213-221. Woodward, H. B., 'The Jurassic Rocks of Britain,' vol. iii, (*Mem. Geol. Surv.*), 1893, p. 142.

The water-level in September, 1903, stood at about 10 ft. below the surface, but to all intents and purposes no water was met with in the Lower Lias.

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Gloucester Spa

Gloucester Spa was closed in 1926 owing to the medicinal waters in two of the wells having become polluted and the water in the third much reduced in strength.

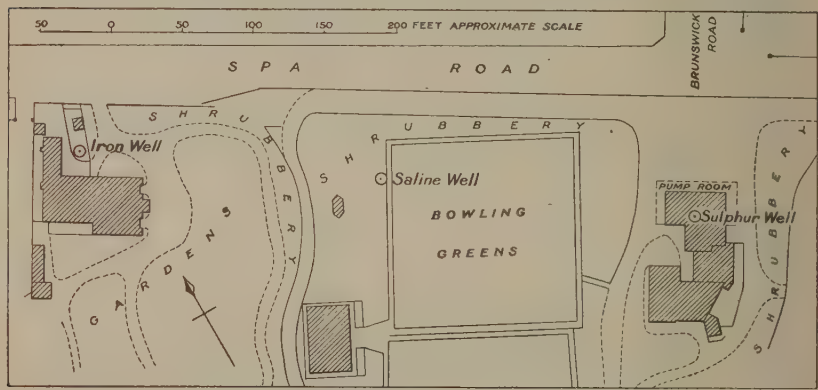

Fig. 8.—*Map showing sites of wells at Gloucester Spa (closed).*

There were three wells :—

1.—Iron or Chalybeate Well in private grounds. Sunk about 1749 in search of a domestic supply for St. Luke's House but medicinal water found. Depth now unascertainable owing to obstructions in the well. In Lower Lias on the surface of which are a few 'Drift' pebbles. Said to be dry-steined.

2.—Saline or Bowling Green Well. Sunk apparently in 1762, for it is said that these figures were found cut on a stone at the bottom of the well. Depth about 90 ft. In Lower Lias. Collar of well cemented ; dry-steined below.

3.—Sulphur Well. Under the floor of the Pump Room immediately in front of the counter. Sunk ? 1814. Depth about 85 ft. In Lower Lias. Cemented between floor and wood-staging that rests on the ground ; dry-steined below.

About 1814 the Pump Room was erected and piping laid by which the waters from all three wells were made available therein.

In 1830 Prof. Daubeny made known his discovery of iodine and bromine in the waters.

In 1839 Dr. A. B. Granville visited the Spa. In his book he described the water of the Bowling Green Well as a 'strong saline' but devoid of sulphuretted hydrogen and iron.

Analyses of the waters made by G. Embrey in 1889 and 1905 were published in 1889 and 1919 respectively.

To give an idea of the medicinal contents of the waters the necessary items have been taken from the last analyses made by Rowland H. Ellis, F.I.C., on February 23rd, 1926. Samples taken at the bottom of the wells.

	Parts per 100,000		
	Chalybeate Well	Saline Well	Sulphur Well
Chemical Analysis.—			
Total dissolved solids	110·88	995·92	926·14
Combined chlorine	11·25	533·50	509·2
Nitrogen as nitrates	none	none	none
Nitrogen as nitrites	none	none	none
Mineral ammonia	0·0048	0·1428	0·1132
Organic ammonia	0·0028	0·0112	0·0184
Temporary hardness	31·0	23·0	52·0
Permanent hardness	16·0	60·5	15·0
Total hardness	47·0	83·5	67·0
Mineral Analysis.—			
Combined chlorine	11·25	533·50	509·20
Combined carbon dioxide	13·64	10·12	22·9
Combined sulphuric anhydride ...	35·64	57·48	21·8
Silica	0·30	0·80	1·1
Oxide of iron	0·16	trace	0·44
Oxide of alumina	1·16	0·92	0·88
Lime (as CaO)	18·02	21·22	17·4
Magnesia (as MgO)	4·98	16·74	15·7
Alkalies (as Na_2O)	27·98	474·21	450·1
The most probable combination of the above is as follows :—			
Calcium carbonate	29·36	23·00	31·07
Calcium sulphate	4·83	22·68	18·57
Magnesium sulphate	14·94	50·22	22·14
Sodium sulphate	41·59	18·94	12·49
Sodium chloride (common salt) ...	18·54	879·51	839·18
Silica	0·30	0·80	1·08
Ferrous carbonate	0·23	trace	0·63
Oxide of alumina	1·16	0·92	0·88
Dissolved gases.—			
Total gases	none	5·4c.c. per litre	14·6c.c. per litre
Sulphuretted hydrogen			0·4c.c. per litre

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[1] According to a note made by Dr. F. T. Bond on the copy of this pamphlet in the Public Library, Gloucester, the water was found in lower Westgate Street. See R. Austin, Catalogue of the Gloucestershire Collection . . . in the Gloucester Public Library . . . 1928, p. 421.

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Bristol—Maps : 264 ; [35] ; (71 N.W., N.E., S.W., S.E., 72 N.W., N.E., S.W., S.E., 75 N.E., 76 N.W.)

The ancient water supplies of Bristol—for which it was largely indebted to its Monasteries—were derived from local sources and conveyed by conduits to convenient spots in the old city. On the suppression of the Monasteries, their maintenance devolved upon the churchwardens. Some of the old conduits are still in existence, but the extension of building and the ramifications of modern sewerage systems endangered the safety of, and interfered with, many of them.

In 1846 the Health of Towns Commissioners reported that Bristol, then containing 130,000 inhabitants, had a most inadequate water supply, probably more so than any other town of equal size in England. In consequence, the Bristol Waterworks Company was formed in 1846, and the city has now an excellent supply obtained from sources in Somerset.[1]

Few wells are now known officially to be in use for domestic purposes, and those in the areas taken in at the 1904 enlargement of City Boundary are rapidly being abandoned in favour of the Company's water. Some of the large manufacturing concerns have private supplies from deep wells (dug and bored) and particulars of a number of these are given (pp. 227 *et seqq*). It is useful to note that known attemps to obtain water by boring into the Coal Measures have all proved failures : the water is met with in the Keuper beds and is held up therein by the subjacent Coal Measures.

The Ham Green Infectious Diseases Hospital near Pill is included in the City Boundary and is supplied to the extent of about 10,000 gallons a day by the Portishead Water Company. The rest of the supply is taken from a lake on the estate, which is fed by springs, but is not used for drinking purposes.

Bristol Waterworks Company.—In addition to the City and County of Bristol this Company also supplies parts of the parishes of Blagdon (Axbridge R.D., Somerset) ; Brislington (Keynsham R.D., Somerset) ; Abbots Leigh, Blackwell, Barrow Gurney, Bishopsworth, Brockley, Flax Bourton, Long Ashton, Nailsea, Wraxall (Long Ashton R.D., Somerset) ; Henbury (Thornbury R.D., Glos.), and furnishes a supply in bulk to Clutton R.D. (Somerset).

Powers.—Bristol Waterworks Acts, 1862, 1872, 1882, 1888, 1889, 1895, 1900, 1902, 1914, 1917, 1921 ; Bristol Waterworks Amendment Act, 1865.

Limits.—Same as area supplied.

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[1] These sources are described in detail in the 'Wells and Springs of Somerset' (*Mem. Geol. Surv.*), 1928, pp. 209-216.

Sources of Supply.—A. D. Alexander, the Secretary of the Waterworks Company, informs me that on its incorporation the Company purchased certain wells and springs within the Borough, but that all these were closed down many years ago. The present sources of supply are all in Somerset, and are :—

1. River Yeo and its tributary streams and springs with drainage area of 14 square miles in Blagdon, Ubley, Compton Martin, Nempnett, Butcombe and Burrington.
2. Springs in Chewton Mendip, West Harptree, Hinton Blewett.
3. Sherborne Spring, Litton.
4. Cold Bath Spring, Barrow Gurney.
5. Elwell and Dundry streams in Winford, Dundry and Barrow Gurney.
6. Chelvey Wells in Trias at Chelvey, Flax Bourton.
7. Cheddar, from stream.

Works.—Water is filtered except from (3), 259 gallons per sq. yd. per day. Storage reservoir—Yeo, 1,700,000 gallons ; Barrow Store (*a*) 143,951,000 gallons, (*b*) 188,631,000 gallons, (*c*) 520,000,000 gallons. Service reservoirs.—Bedminster Down, 5,000,000 gallons ; Victoria, 6,750,000 gallons ; Durdham Downs, 586,000 gallons ; Knowle (near Knowle House), 350,000 gallons ; Leigh Tank, 39,000 gallons ; St. George's Tank, 36,000 gallons ; Knowle Tank, 60,000 gallons. Pressure is sufficient.

Quantity of water supplied.—The daily average is 12,139,000 gallons, and the number of premises connected with the mains is (Nov. 24th, 1921) 78,599.

Quality of water.—Excellent. Hardness: temporary, 7° ; permanent 5° ; total 12°.

'*The Boiling Wells.*'—'The Boiling Wells' are situate in a depression about 100 yds. to the south-east of Ashley Hill Station. They are under the control of the Bristol Waterworks Company, by whom they have been let to the Bristol United Brewery Company, who find the water very suitable for brewing purposes.

H. W. Pearson stated that the springs yield from half to three quarters of a million gallons of good pure water per day, which comes from a depth of 18 to 21 ft. or from a level of about 50 ft. above O.D.[1]

The water from the 'wells' or springs discharges into the stream that rises on the Lower Lias north of Berrylane Farm. The Lower Lias beds north of Ashley Hill Station dip north-west by west, and the water seeping out therefrom gave much trouble during the construction of the Great Western Railway line.[2]

St. Ann's Well.—The well is situate near the bank of the River Avon opposite Crews Hole and ⅜ mile north of St. Anne's Park Station on the Great Western Railway line from Bristol to Bath.

Boring at Avonside Paper Mills.—Little Avon St., St. Phillips. Made by and particulars communicated by, Messrs. C. Isler & Co., Ltd. Surface-level about 33 ft. above O.D.

		Thickness Ft.	Depth Ft.
	Made ground	4	4
	Marl and ballast	6½	10½
[Keuper]	Red marl	5½	16
	Grey sandstone	8½	24½
	Red marl	12	36½
	Red sandstone	26	62½
	Red marl	39½	102
	Grey stone	9½	111½
	Red marl	10	121½
	Red sandstone	3½	125

[1] *Proc. Bristol Nat. Soc.*, vol. viii, pt. 2, 1898, p. 174.
[2] *Ibid.*, vol. vi, p. 317.

Lined with 15 ft. of 11½-in. tubes from 3 ft. below the surface. Water-level about the time of sinking—10 ft. below surface. Yield after completion of sinking—6,000 gallons per hour.

Boring at Messrs. Baker, Baker & Co., Ltd., Wine Street.—Made (1883) by, and particulars communicated by, Messrs. LeGrand and Sutcliff.

Surface-level—? about 40 ft. above O.D.

Boring (15-in. diameter)—
[Keuper] Sandstone ... ... 66 ft.

Water-level—4 ft. below surface.

Boring at the Bedminster Smelting Works.—Mill Lane, Bedminster. (Messrs. Capper Pass and Co., Ltd.)

Surface-level—about 30 ft. above O.D.

	Thickness Ft.	In.	Depth Ft.	In.
Boring :—				
Top soil	2	0	2	0
Brown clay	3	0	5	0
Mottled clay	3	0	8	0
Hard clay	8	0	16	0
Red marl	14	0	30	0
Marl rock	22	0	52	0
Rotten sandstone	2	0	54	0
Mottled shale	4	0	58	0
Hard grey shale	8	0	66	0
Soft grey shale	2	0	68	0
Rotten grey shale	8	0	76	0
Black shale	12	0	88	0
Grey stone " bind "	17	0	105	0
Black " bind "	1	0	106	0
Coal	0	6	106	6
Black " bind "	2	0	108	6
Dark grey " bind "	3	6	112	0
Black " bind "	1	6	113	6
Grey " bind "	4	0	117	6
Dark grey " bind " and streaks of coal ...	1	6	119	0
Grey " bind "	6	0	125	0
Black " bind "	0	6	125	6
Dark grey " bind "	13	6	139	0
Stone " bind "	4	0	143	0
Hard grey rock	10	6	153	6
Black " bind "	6	6	160	0
Coal	1	3	161	3
Grey " bind "	7	0	168	3
Dark " bind "	5	3	173	6
Grey " bind "	5	0	178	6
Black " bind "	1	6	180	0
Grey " bind " with stones	19	0	199	0
Hard rock	6	6	205	6
Stone " bind "	3	0	208	6
Rock	7	0	215	6
" Bind " and stones	11	0	226	6
Rock	6	0	232	6
Grey " bind "	5	6	238	0
Black " bind "	1	0	239	0
" Bind " and stones	4	0	243	0
Rock	4	6	247	6

	Thickness Ft.	In.	Depth Ft.	In.
Grey " bind "	7	6	255	0
Coal	0	6	255	6
Black " bind "	3	0	258	6
Coal	0	8	259	2
" Bind "	11	10	271	0
Rock	3	0	274	0
" Bind "	15	0	289	0
Old Pit Working :—				
" Bind "	6	0	295	0
Rock	2	0	297	0
" Bind "	18	0	315	0

Lined with 20 ft. of 13½-in. pipes from 4 ft. below surface.
,, 100 ft. ,, 11½-in. ,, 1 ft. ,,

The boring commenced in Keuper beds but, from the information available, it is difficult to state precisely at what depth they end and the Coal Measures begin. It may be suggested that they terminate at 52 ft. down.

Messrs. Capper Pass and Co., Ltd., inform me that at their Works is a well 83 ft. deep (through Keuper rocks and most likely into Coal Measures) 5 ft. in diameter ; depth ex surface to rest-level of water, normally 15 ft. 8 in., but on the 3rd of Feb., 1922, 19 ft. 8 in. The average daily quantity of water drawn is small as the well is only used when the surface-supply runs short. During 1921 the well was only required for a few hours, but when necessary it will yield 7,000 gallons per hour continuously.

Boring at the Bristol Brewery, Bath Street.—(Messrs. Georges and Co., Ltd.)

Site of boring.—On brewery premises near Floating Harbour. Made by Messrs. E. Timmins and Sons, Ltd., Runcorn, in 1915. Messrs. Timmins' record (given below) communicated by A. Hadley, Head Brewer, Messrs. Georges, Ltd.

Surface-level.—About 30 ft. above O.D.

	Thickness Ft.	Depth Ft.
[Made ground] :—		
Ashes, bricks and rubble	21	21
Large stones, clay and rubble	6	27
[River gravel] :—		
Gravel	7	34
[Keuper] :—		
Hard red sandy marl	9	43
Hard red and grey sandy marl	3½	46½
Hard red sandy marl	10½	57
Red and grey sandy marl	1	58
Red sandy marl	2¼	60¼
Fine gravel	1½	61¾
Hard red sandy marl	0¾	62½
Red marly sandstones	1	63½
Red sandstone	7	70½
Red marly sandstone	0½	71
Red sandstone	2½	73½
Red marly sandstone	10	83½
Red pebbly sandstone	0½	84
Red marly sandstone	1½	85½
Grey and yellow sandy shale	6	91½

	Thickness Ft.	Depth Ft.
resting unconformably on.		
[Coal Measures] :—		
Red and grey-blue gritstone	0½	92
Red and blue shaly stone	9	101
Red and blue shale and nodules	8	109
Black shale and coal	2	111
Red and dark blue shale and nodules ...	8	119
Blue shale	6	125
Blue shale and coal	1	126
Blue shale	2	128
Black and dark blue shale	9	137
Dark blue shale	4½	141½
Black shale and coal	2	143½
Coal	0½	144
Dark shale...	1	145
Black shale and coal	7½	152½
Dark blue shale	1½	154
Hard blue shale	1	155
Very hard blue shale	13	168
Hard grey jointy gritstone	14	182
Reddish grey grit with red joints	1	183
Jointy grey gritstone	6	189
Hard jointy reddish grey grit	7	196
Dark shale with coal	30	226
Dark shale and nodules	5	231
Broken shaly grit with calcite joints	12	243
Hard blue shale	5	248
Ironstone nodules	0½	248½
Black shale	3½	252
Hard blue shale	10	262
Dark shaly grit and nodules	18	280
Dark shale with grit beds and ironstone nodules	20	300
Black shale	13	313
Grey broken jointy grit with shale joints ...	12	325
Blue shale with ironstone	9	334
Black shale	1	335
Hard blue shales with ironstone nodules ...	30	365
Grey grit	3½	368½
Black shale	1½	370
Blue shale	15½	385½
Light grey shale	3	388½
Black shale	1½	390
Black shale and coal	9	399
Hard grey grit	1½	400½
Broken grey grit with soft white clay joints ...	1½	402
Hard grey shale with thin grit beds	10½	412½
Broken grey grit	0½	413
Hard grey shale and grit beds	6	419
Broken grey grit	10	429
Dark shale...	0½	429½
Black shale	2½	432
Hard dark grey shale	13	445
Grey shale with beds of ironstone	4	449
Dark shale...	8½	457½
Soft shale, fireclay and coal	5½	463
Hard grey shale	8	471
Broken dark grey grit	7	478
Black shale and ironstones	5	483

	Thickness Ft.	Depth Ft.
Black shale, fireclay and ironstone nodules ...	3	486
Hard grey shale	7½	493½
Hard grey shale with grit beds	14	507½
Grey grit broken in parts	6½	514
Hard shaly grit	2	516
Grey grit	1	517
Broken grey grit	1½	518½
Grey grit	3½	522
Black shale	5	527
Jointy grey grit	2	529
Hard grey shale	8	537
Hard grey shale with beds of grit and ironstone	8	545
Hard black shale and ironstone...	3	548
Hard black shale with nodules	9½	557½
Black shale with marl veins and nodules ...	6½	564
Broken red grit	5½	569½
Red grit	0½	570

Lined with 10½-in. × 11¼-in. tubes down to 65 ft. 2 in. and 9⅞-in. × 10 5/16-in. tubes down to 270 ft.

Perforated with ⅜-in. diameter holes from about 161 ft. to 270 ft., and 9-in. open boring from 270 ft. to bottom.

Highest water-level.—10 ft. below surface 5th April, 1915. Borehole.—362 ft. deep. Water-level.—22 ft. below surface, 2nd Aug., 1915. Borehole.—570 ft. deep. First continuous pumping test, 29th April, 1915, at 370 ft. yielded 1,640 gallons per hour. Second test, 12th Aug., 1915, with borehole 570 ft. deep, showed no increase in water for additional 200 ft. boring.

The boring, of which particulars have been given above, proved unsuccessful, and the Brewery draws its supply from a well concerning which the following details have been communicated to me by Mr. Hadley :—

Site.—On brewery premises near Floating Harbour. Surface-level about 30 ft. above O.D. Depth 86 ft. and 8 ft. in diameter, with tunnels at bottom 174 ft. in length, 6 ft. high and 6 ft. broad. Rest-level.—11 ft. ex surface. Average daily quantity of water pumped—100,000 gallons in the winter; 250,000 in the summer. Owing to the underground storage the effect of droughts is not greatly felt.

The rocks penetrated by the well are :—

		Thickness Ft.
	Made ground	27
[River Gravel]	Gravel	7
[Keuper]	Beds similar to those penetrated by the borehole	52

Boring at the British and Argentine Meat Co.'s Stores, Bathurst Wharf.—Near the General Hospital.

Made by, and particulars communicated by, Messrs. H. Brown & Co., 66, Prince Street, Bristol.

Surface-level.—About 35 ft. above O.D.

		Thickness Ft.	Depth Ft.
	Shaft :—		
	Made ground	7¼	7¼
[Alluvium] (42 ft.)	Blue clay	0¾	8
	Boring :—		
	Blue clay	35¼	43¼
	Clay and gravel	6	49¼

		Thickness Ft.	Depth Ft.
[Keuper] (87 ft.)	Marl rock	22	71¼
	Sandstone	2½	73¾
	Red sandstone with bands of marl	53	126¾
	Conglomerate	9½	136¼
[? Coal Measures] (28 ft.)	Shale	4	140¼
	Pennant Stone	3	143¼
	Running sand	1½	144¾
	Coarse sand	1	145¾
	Red sandstone with bands of marl	18¼	164

Rest-level.—18 ft. below the surface.

Yield.—About 1,200 gallons per hour (capacity of pump).

Boring at Caxton Works, Temple Gate.—(Messrs. John Mardon, Son and Hall.)

Made by, and particulars communicated by, Messrs. C. Isler & Co., Ltd. Surface-level.—About 35 ft. above O.D.

		Thickness Ft.	Depth Ft.
[Keuper]	Red sandstone	18	18
	Red marl	14	32
	Red sandstone	1½	33½
	Red marl	19½	53
	Mottled marl	12½	65½
	Red sandstone	10	75½
	Red marl	29	104½
	Red sandstone	5	109½
	Red marl	15	124½
	Dark marl	13½	138

Lined with 80 ft. of 7¼-in. perforated tube.
,, 10 ft. ,, 8½-in. plain.

Boring at Messrs. Chappell, Allen & Co., Ltd., Victoria Avenue, Redfield.

Made by Messrs. C. Isler & Co., Ltd. Particulars communicated by Messrs. Isler and Messrs. Chappell, Allen & Co. Surface-level.—81·2 ft. above O.D.

	Thickness Ft.	Depth Ft.
Sandstone	8	8
Grey rock	9	17
Mottled marl	1	18
Grey rock	7	25
Mottled clay	5	30
Blue clay	18	48
Blue stone...	5	53
Blue clay	18	71
Pebbles	10	81
Blue rock	25	106
Blue marl	13	119
Hard blue marl	49	168
Marl and shale	5	173
Coal	1	174
Sand and marl	14	188
Sandstone	9	197
Coal and marl	1	198
Stiff marl	4	202
Coal	1	203
Shale and marl	3½	206½

Lined with 80 ft. of 6-in tube from 6 ft. below surface. Water level about the time of sinking, 18 ft. below the surface; 27th Jan., 1922—54 ft. Yield, 2,000 gallons per day. Effect of drought of 1921, none. Quality of water, good.

This boring is through a thin covering of Keuper into Coal Measures, but from the information available it is difficult to state precisely the thickness of rock that belongs to the Keuper.

Boring, Ashton Gate Brewery Co., Ltd.—Made and particulars communicated by Messrs. C. Isler & Co., Ltd.

		Thickness Ft.	Depth Ft.
Shaft (the rest bored)		43½	43½
[? Valley Drift]	Sand...	2½	46
[Trias]	Red bind	5	51
	Red and blue bind	4	55
	Marl, very binding	4	59
	Red stony marl	7	66
	Hard red stone	5½	71½
[Coal Measures ?]	Iron band	3¼	74¾
	Spar and hard sandstone	1½	76¼
	Red mixed marl	2	78¼
	Shaly marl	5	83¼
	Dry gault [clay]	2½	85¾
	Pit down	4¼	90
	Mixed stone	2¼	92¼
	Red shaly marl	2	94¼
	Hard stone	1¼	95½
	Stony marl	1¼	96¾
	Pit down	3½	100¼

Result.—No supply.

Boring at the New City Brewery, River Street, St. Judes.—(Messrs. J. & T. Usher, Ltd.)

Made by, and particulars communicated by, Messrs. C. Isler & Co., Ltd. Surface-level.—About 36 ft. above O.D.

		Thickness Ft.	Depth Ft.
	Made ground	3	3
[Keuper]	Red marl	3	6
	Red sandstone	4½	10½
	Gypsum	7	17½
	Marl	2¾	20¼
	Red sandstone	8	28¼
	Marl...	3	31¼
	Sandstone	6	37¼
	Red marl, hard	5	42¼
	Sandstone	3	45¼
	Red marl	3½	48¾
	Sandstone	10	58¾
	Marl (various colours)	3	61¾
	Sandstone	9	70¾
	Marl...	2½	73¼
	Sandstone	7	80¼
	Marl...	2	82¼
	Sandstone	10	92¼
	Mottled clay	3	95¼
	Sandstone	8	103¼
	Marl...	2½	105¾

		Thickness Ft.	Depth Ft.
	Sandstone	10	115¾
	Marl...	3½	119¼
	Sandstone	3¼	122½
	Shale	7	129½
[? Coal Measures]	Hard sandstone	7	136½

Lined with 50 ft. of 10-in. tubes from 5 ft. below surface. Water-level, 8 ft. from surface. On the 15th Feb., 1922, Messrs. Usher informed me that the daily quantity of water drawn " varies very much now."

Boring at Filton.—Made for Messrs. S. Shield, Ltd., Filton Laundry. Particulars communicated by Messrs. C. Isler & Co., Ltd., 1923-24.

		Thickness Ft.	In.	Depth Ft.	In.
	Made up ground	6	0	6	0
[Lower Lias]	Blue clay	18	0	24	0
	Clay : boulders of limestone ...	49	0	73	0
	Blue lias	5	8	78	8
[Coal Measures—Pennant-Grit]	Cattybrook clay	25	4	104	0
	Shale (Rods in 98′, Rods out 104′)	28	6	132	6
	Shale and red clay (Rods in 121′, Rods out 128′ 4″)	26	0	158	6
	Blue pennant rock (tubed and water shut out)	40	0	198	6
	Shale and clay	2	6	201	0
	Red pennant	42	4	243	4
	Shale	2	6	245	10
	Red pennant or ironstone ...	15	8	261	6
	Blue pennant	38	0	299	6
	Shale and clay	3	6	303	0
	Red pennant	35	0	338	0
	Shale	3	6	341	6
	Red pennant	19	0	360	6
	Shale	1	6	362	0
	Blue pennant	28	0	390	0
	Shale (Rods in 114′ 2″, Rods out 115′ 6″)	6	6	396	6

Tubes.—152 ft. of 8-in. tubes, top level with surface.
Yield.—3,882 gallons per hour.
Levels.—Standing, 115½ ft. down ; pumping, 129 ft. down.

Old Pylemarsh Pit.—Pile Marsh is situate to the south-east of Redfield, and the pit was therefore not far from the factory of Messrs. Chappell, Allen and Co., Ltd. (p. 232).

The record of the well is published in the report of the Royal Coal Commission and reprinted in the ' Geology of East Somerset and the Bristol Coal Fields ' (*Mem. Geol. Surv.*), 1876, pp. 28-39.

Boring at Redcliffe Iron Works.—(Messrs. Sinn, Ltd.). Boring made and particulars communicated by Messrs. C. Isler & Co., Ltd.

		Thickness Ft.
	Dug well :—	57
	Boring :—	
[Keuper]	Red marl	42
	Sandstone	104

Water-level.—14 ft. below the surface. Yield.—Overflowed from top of pipe into the well at the rate of 1,130 gallons per hour. When pumping, yield at the rate of 6,000 gallons per hour.

Boring at Messrs. W. J. Rogers, Ltd., Old Market Street, Bristol.—Messrs. W. J. Rogers, Ltd., Brewers, have furnished me with the following particulars concerning their sources of supply :—

Boring made by Messrs. C. Isler & Co., Ltd. (1876). Surface-level.—68 ft. above O.D. Top of well about 30 ft. below street-level.

		Thickness Ft.	Depth Ft.
	Made ground, sand and marl ...	37	37
[Keuper] (115 ft.)	Red fissured sandstone	43	80
	Soft fissured sandstone	50	130
	Hard white-veined sandstone ...	1	131
	Bed of hard stone, striated sandstone	21	152
[Coal Measures] (148 ft.)	Bluish soft shales	8	160
	Shales	110	270
	Hard dark shales	30	300
	Shales with coal	—	—

This bore was originally made to the depth of 1,000 ft., and all water was lost. It was then plugged up to 300 ft. and now yields about 30,000 gallons per 24 hours.

Rest-level.—20 ft. below top of well. The rest-level was lower during the drought of 1921.

The supplies are drawn from this well by two sets of small three-throw pumps situated in the well and sometimes submerged.

W. W. Stoddart published an account of the rocks passed through by this boring down to 300 ft. The thicknesses he gives of the beds do not agree precisely with those given by Messrs. Rogers, but the following remarks of his are worth repeating :—" The first 10 ft. is ordinary made ground lying upon 13 ft. of marls, more or less sandy. Gravel is, however, not so constant as at the Hotwells, Cumberland basin, and other parts of the city, but sufficiently so to cause a connection to be formed between the water in the surface wells and that of the tide, the level of the well water rising and falling with that of the tidal water. The next 97 ft. pass through a soft reddish sandstone, which is succeeded by harder sandstone with white veins, mixed with nodules and hard blocks of the coal measures.

" The remaining 145 ft. of the shaft passes through dark coal shales. These when first brought to the surface are nearly black, but on subsequent exposure and consequent drying, change to a light drab and easily fall to powder for want of a proper binding consistency. These shales differ much in their degree of hardness, some being very soft, whilst some others are stony and almost nodular.

" On reaching the depth of 300 ft., a bit of coal was found, and a bit of real, though impure, coal was brought to the surface."[1]

Messrs. Rogers also state :—" Our other supply comes from a bore (9-in. diameter) which is situated about 50 yards from the above. The bore is 210 ft. deep and the working barrel is situated about 90 ft. down the bore, and the rest-level is about 40 ft. from the top of the bore. The top of this bore is about 30 ft. below the street-level. The supply is about 70,000 gallons per 24 hours and was not affected to any great extent by the drought of 1921."

[1] *Proc. Bristol Nat. Soc.*, new ser., vol. ii (1878), pp. 77-78.

Boring at Stoke Park Colony, Stapleton.—Made and communicated by Messrs. H. Brown & Co., Bristol in 1923.

Boring (diameter, 8 in.) :—

[Keuper resting on Coal Measures]	Cliff and pennant with a little marl ...	469 ft.

Yield.—A very small supply.

Borings for the Co-operative Society, Avonmouth.—1. Made and particulars communicated by Messrs. C. Isler & Co., Ltd. Boring commenced 16th June, 1902; finished 4th July, 1902. Surface-level.—25 ft. above O.D.

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
[Alluvium]	Clayey soil	1	0	1	0
	Greenish clay	6	6	7	6
	Mottled clay	5	6	13	0
	Mottled sandy clay	3	0	16	0
[Keuper]	Red marl	30	0	46	0
	Red rock, hard	2	0	48	0
	Red marl	12	0	60	0
	Red rock	1	9	61	9
	Red marl	0	4	62	1
	Red rock	4	4	66	5
	Thick layer of rock and thin marl	7	1	73	6
	Hard red rock	5	6	79	0
	Layers of red rock and marl ...	7	0	86	0
	Grey sandy marl	1	0	87	0
	Layers of red rock and marl ...	2	0	89	0
	Red rock	3	6	92	6
	Red rock and marl	10	0	102	6
	Red rock and marl and a little grey sand	6	6	109	0
	Layer of rock red and marl ...	7	6	116	6
	Red marl and rock	5	0	121	6
	Hard red rock	3	6	125	0
	Very hard grey and red rock ...	0	9	125	9
	Hard grey rock	2	6	128	3

Lined with 70 ft. of 4-in. tubes top 2 ft. 10 in. below surface. Water-level.—18 ft. below surface. Quality.—Bad.

§ 2. Flour Mills. Made in 1924-25 by Messrs. C. Isler & Co., Ltd., and particulars communicated by the Co-operative Wholesale Society.

			Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
[Alluvial and ? old beach]	Made ground	Some brackish water got, but was cut off. [Water, 21 ft. F.S.W.]	3	0	3	0
	Brown clay		7	0	10	0
	Soft blue clay		45	0	55	0
	Pebbles		5	0	60	0
[Keuper]	Red marl and sandstone		11	0	71	0
	,, and limestone		4	6	75	6
	Sand, red marl and limestone ...		11	0	86	6
	Rock		7	6	94	0
	Marl and limestone		5	0	99	0
	Rock and marl		10	6	109	6
	Rock		8	6	118	0
	Sandstone and marl		3	0	121	0
	Sandstone		6	7	127	7
	Sandstone and rock		5	0	132	7

		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
[Coal Measures—Pennant Grit]	Grey Pennant rock	6	0	138	7
	Sandstone and rock	5	0	143	7
	Red rock and pebbles [Pocket of Dolomitic Conglomerate. Water.]	7	1	150	8
	Conglomerate rock	23	8	174	4
	Red marl	2	0	176	4
	Red marl and rock	4	0	180	4
	Pennant rock (split)	15	0	195	4
	Broken Pennant rock	4	8	200	0
	Pennant rock	75	6	275	6
	Blue shale	88	6	364	0
	Hard blue marl	12	6	376	6
	Blue shale	29	0	405	6
	Hard blue shale	11	0	416	6
	Hard grey rock	8	6	425	0
	Hard blue shale	53	0	478	0

Tubes :—61 ft. 6 in. of 15-in., top 4 ft. below surface ; 102 ft. 2 in. of 12-in. top level with surface ; and 170 ft. of 10-in., top 6 in. above surface.

Yield.—No particulars as to yield, if any. [Dr. F. S. Wallis, who saw portions of the core, informs me : "There was a definite pocket of Dolomitic Conglomerate in the Pennant and water was then (1st Dec., 1924) at two levels—quite a fair supply from the Dolomitic Conglomerate"].

Boring at Newtown, Avonmouth.—Made in 1921 by and particulars communicated by Messrs. H. Brown & Co., Bristol.

		Thickness Ft.	Depth Ft.
	Sandy marl, gravel and stones ...	8	8
[Alluvium]	Clay	37	45
[Keuper]	Red sandstone with bands of marl	83	128
	Red marl with a few bands of sandstone	233	361

Boring at West Town, Avonmouth.—Made and communicated by Messrs. H. Brown & Co., Bristol.

		Thickness Ft.	Depth Ft.
[? Alluvium]	... ...	37	37
[Keuper]	Red sandstone	83	120

Total depth, 475 ft., when pumping test yielded 1,800 gallons per hour for several days.

Boring at Oil Tanks, Avonmouth.—"In 1890, new oil tanks and stores were erected at Avonmouth. We were consulted respecting the water supply for the engines, boilers, etc. I found them water, and sunk a bore-hole to the depth of 48 feet ; the water rose to within 12 feet of the surface, but after some time was given up, because the water was brackish, the hole being close to the tidal river."[1]

ANALYSES OF BRISTOL WATERS

1. Hotwell, in Carboniferous Limestone.
2. St. Vincent's Spring, from Carboniferous Limestone, Avon Gorge.
3. Jacobs Wells (Dean and Chapter's Spring), Clifton, in Millstone Grit. Polluted.
4. Jacobs Wells (Corporation Spring). Polluted.

[1] Mereweather, W., *in litt.* 1st May, 1893, to Prof. [Sir] W. F. Barrett, published in *Proc. Soc. Psychical Research*, vol. xiii, 1898, p. 73.

Analyses made and communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

	Grains per gallon			
	(1)	(2)	(3)	(4)
Saline ammonia	·0003	·0000	·0006	·0007
Albuminoid ammonia ...	·0010	·0003	·0025	·0029
Nitrogen as nitrate ...	·506	·287	1·90	1·55
Nitrites	—	—	—	trace
Chlorine and chloride ...	5·1	2·6	3·3	3·3
Dissolved solids	75	49	64	58
Earthy carbonates ...	18·0	21·0	17·5	20·0
Earthy salts not carbonates	22·5	13·0	18·5	15·0
Hardness	41·5	35·0	37·0	36·0

Note: The "earthy carbonates" refer to calcium and magnesium carbonates, the "earthy salts not carbonates" (Ca and Mg) SO_4, NO_3, and Cl. The hardness is arrived at by adding these together +1 for the soap required to lather distilled water.

Bristol.—Bishopston

Well in Lower Lias at 146, Gloucester Road, Bishopston.

Analysis made and communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

	Grains per gallon
Saline ammonia	·0019
Albuminoid ammonia	·0044
Nitrogen as nitrates...	·517
Nitrites	present
Chlorine as chloride	1·9
Dissolved solids	34
Earthy carbonates[1]	13
Earthy salts not carbonates	7
Hardness	21

Bristol.—Downend and Horfield.

Wells in Lower Lias at :—

1. Lockleaze Farm, Horfield.
2. Berry Lane. Farm. Polluted.
3. Downend.
4. St. Anne's Cottages, Horfield Common.

Analyses made and communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

	Grains per gallon			
	(1)	(2)	(3)	(4)
Saline ammonia	·0011	·0011	·0064	·0042
Albuminoid ammonia ...	·0080	·0095	·0265	·0060
Nitrogen as nitrates ...	·31	2·7	2·71	1·27
Nitrites	—	trace	present	trace
Chlorine as chloride ...	2·3	6·8	6·7	6·0
Dissolved solids	41	79	93	211
Earthy carbonates[1] ...	23	21·5	23·0	28·5
Earthy salts not carbonates	6	7·5	25·5	76·5
Hardness	30	30·0	49·5	106·0

[1] See Note, p. 244.

Bristol.—St George's

Wells in Coal Measures at :—

1. Bryants Hill.
2. Marling Road.
3. Church Road.
4. Speedwell Road.

Analyses made and communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

	Grains per gallon			
	(1)	(2)	(3)	(4)
Saline ammonia	·0010	·0017	·0012	·0008
Albuminoid ammonia ...	·0049	·0057	·0059	·0047
Nitrogen as nitrate ...	·357	·226	·57	·12
Nitrites	—	—	trace	—
Chlorine as chloride ...	5·8	5·2	1·8	2·6
Dissolved solids	97	87	25	39
Earthy corbonates[1] ...	18·5	26·0	6·0	11·5
Earthy salts not carbonates	36·0	19·5	6·0	9·5
Hardness	55·5	46·5	13·0	22·0

Bristol.—Sea Mills

Well in Dolomitic Conglomerate.

Analysis made and communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

	Grains per gallon
Saline ammonia	·0007
Albuminoid ammonia	·0017
Nitrogen as nitrate	·403
Nitrites	trace
Chlorine as chloride	19·6
Dissolved solids	80
Earthy carbonates[1]	25·5
Earthy salts not carbonates	14·5
Hardness	41·0

Bristol.—Shirehampton.

1. Well in Keuper Marl at Bamhill Farm, Shirehampton.
2. Well in Keuper Marl at Myrtle Farm, Shirehampton.

Analyses made and communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

	Grains per gallon	
	(1)	(2)
Saline ammonia	·0007	·0010
Albuminoid ammonia	·0028	·0033
Nitrogen as nitrate	·541	·202
Nitrites	—	trace
Chlorine as chloride	5·8	4·2
Dissolved solids	64	43
Earthy carbonates[1]	30	26·5
Earthy salts not carbonates ...	4	0
Hardness	35	27·5

[1] See Note, p. 244.

Bristol.—Westbury-on-Trym

1. Well in Dolomitic Conglomerate, Canford House, Westbury-on-Trym.
2. Spring issuing from Dolomitic Conglomerate, Coombe Farm, Westbury-on-Trym.
3. Well in Carboniferous Limestone, Claremont, Westbury-on-Trym.
4. Well in Carboniferous Limestone, Brentry Farm, Westbury-on-Trym.

Analyses made and communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

	Grains per gallon			
	(1)	(2)	(3)	(4)
Saline ammonia	·0336	·0013	·0003	·0005
Albuminoid ammonia ...	·0028	·0091	·0056	·0028
Nitrogen as nitrate ...	·218	·368	·805	·058
Nitrites	trace	trace	—	—
Chlorine as chloride ...	2·2	2·2	5·0	1·4
Dissolved solids	45	43	65	35
Earthy carbonates [1] ...	17·5	29	22·5	24·0
Earthy salts not carbonates	2·0	0	17·5	1·5
Hardness	20·5	30	41·0	26·5

Thermal Waters.

The well-known Hotwell Spring issued in considerable volume from an aperture in the Carboniferous Limestone at about 26 ft. below high-water mark and 10 ft. below low-water mark at the foot of St. Vincent's Rocks and discharged into the River Avon.

William Wyrecestre referred to the spring in his itinerary and establishes the fact that long before his time it was noted for its curative properties. He said it was "like the water of Bath."

In 1691 Sir John Knight, Mayor of Bristol, had stonework erected round the spring to prevent the tide from mixing with it, but the impounding of the waters caused them to find a new outlet and the spring was in danger of being lost. In 1695 the Merchant Venturers granted a lease for building to Sir Thomas Day, Robert Yates, Thomas Collanhill, and others, who recovered the spring, built the Hotwell House, made proper foundations for pumps (which raised the water 30 ft.) and laid pipes through which the waste water could escape but—owing to valves—Avon water could not run in. The water when taken from the pumps had a maximum temperature of 76°Fahr., but usually about 73°F., while that in the neighbouring 'rock house' was 50°F.

The Assembly Room and Pump Room were pulled down about 1870 when the Hotwell House Point was removed for the widening of the river, and the spring was apparently left to run its course until Mr. Howard, of the Docks Committee Staff, took interest in it and a pump was erected and overflow sluice provided.

On the property of the St. Vincent's Rocks Hotel is a well 245 ft. deep in the Carboniferous Limestone which taps hot water—the old Sion Spring—similar to that of the Hotwell Spring. A supply of 34,000 gallons a day has been obtained.

Thos. A. Peace, Docks Engineer of the Port of Bristol, informs me that he believes there are one or two borings at the Rocks Railway tapping water similar to that of the Hotwell Spring, but that the only one of which the position is definitely known at the present time is that opposite the entrance to the Rocks Railway. It is 70 ft. deep and has a diameter of 5 in. He states (*in litt.*, 1st June, 1922) :—"This boring is now being investigated by the Docks Committee because it was found in 1914 that the water being used at the old Hotwell Spring was to some extent contaminated by the water from the River Avon. At present we have no knowledge of its daily output.

[1] See Note, p. 244.

"The outlet of the Hotwell Spring is in the bed of the River Avon, and although several attempts have been made to close this up so as to prevent contamination, we have not been successful in so doing: as soon as one place is stopped up another breaks out through a rock fissure."

Analyses of two samples of the Hotwell Water by Edward Russell, Public Analyst, Bristol. Report for 1909, p. 22:—

	Parts per 100,000		Grains per gallon	
Total solids	109·25	111·25	76·47	77·87
Mineral matter	87·50	84·75	61·25	59·32
Organic matter	21·75	26·50	15·22	18·50
Chlorine as chlorides ...	8·0	7·9	5·6	5·5
Hardness	—	—	34·8°	34·0°
Free ammonia—traces ...	nil	nil	nil	nil
Albuminoid ammonia ...	·002	·001	·0014	·0007
Total oxydized nitrogen ...	·8	1·21	·56	·84
Nitrites	nil	nil	nil	nil
Permanent hardness ...	—	—	13·2°	13·2°
Lead	nil	nil	nil	nil

Mineral Analysis:—

SiO_2	·0174	grammes per litre.
Al_2O_3 and Fe_2P_3 ...	·0048	,, ,,
CaO	·2900	,, ,,
MgO	·0472	,, ,,
SO_3	·3100	,, ,,

Spectroscopic Examination. Strontium traces.

The water of this historic well shows no evidence of pollution and is fairly constant in composition.

Radio-active Waters

Particulars communicated by H. F. Barke, F.I.C., Public Analyst, Bristol.

Source	Formation	Temp.	Niton $\times 10^{-12}$
1. Brandon Hill. Public Fountain	Millstone Grit ...	—	22
2. Will's Brook, Somerset side of Avon	Carboniferous Limestone	—	863
3. Stork Hotel Well, Hotwells Road	Millstone Grit ...	—	45
4. Bristol Public Supply	—	—	9
5. The Hotwell	Carboniferous Limestone	72°F.	1,550
6. Well in Colonade	Do.	—	418
7. St. Vincent's Spring, Avon Gorge	Do.	68°F.	714
8. Rocks Railway Borehole ...	Do.	—	824

In the course of a Report 'Upon the Radio-Activity of the Hotwell Spring, Bristol,' No. 5 above, made in Oct., 1912, Messrs. H. F. Barke, F.I.C., and H. T. Sully, M.I.E.E., state:—"During the last three weeks we have been investigating the Radio-Activity of the above-mentioned Spring. . . .

"Taking the average of four tests we find that the amount of Radium Emanation or Niton shows an effect equal to the activity of 0·93 milligram of Radium in a million litres of the water. We also find that the sooner the determination is made after sampling the larger the amount of Niton obtained.

The four determinations from which the above result was obtained are 0·924, 0·85, 0·86, and 1·09 in milligrams of Radium per million litres of water, the first and last test being made at the Western Counties Laboratory, where the tests were made within an hour of its being drawn from the spring, and the second and third at Mr. Herbert T. Sully's private Laboratory in Durdham Park, where about three to four hours elapsed between the time of drawing the water and making the test.

. . . . . .

"It may be interesting to further state that we found that there is a large amount of dissolved gases in the Hotwell water, namely, about 60 cubic centimetres per litre.

"Note.—The figures given for Radium in this Report are all to be taken as the amount of Radium Emanation or Niton that would be represented by the amounts of Radium given when in a state of equilibrium."

Mr. Barke informs me (June 11, 1922) that "the figure for the Hotwell given in the list [above] is higher than in the Report being a better and later determination."

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VI.—ANALYSES OF WATERS

Analyses of Bristol waters are given under Bristol, and of the Cheltenham and Gloucester Medicinal Waters under those towns.

Alstone

1.—Alstone Village Well.—Water from sand-bed resting on Lower Lias. Analysis by the late George Embrey, F.I.C., F.C.S., County Analyst, Gloucestershire, communicated by C. Gardner, Surveyor, Winchcomb Rural District Council.

2.—Tap at Alstone Fields Farm.—Water from a sand-bed resting on Lower Lias at "Sexty's Grounds" between Bengrove and the Tewkesbury-Stow road. Made by G. Embrey and communicated by C. Gardner.

	(1)	(2)
	Parts per 100,000	
Total solid matter	54	48
Combined chlorine	3·2	1·4
Nitrites and nitrates	nil	nil
Mineral ammonia	·008	nil
Organic ammonia...	·002	·007
Oxygen required for combustion of organic matter ...	·073	·02
Hardness in degrees—		
Permanent	10·4	10·45
Temporary	21·6	25·6
Total	32·0	36·05
Micro-organisms per c.c.	270	—
Bacillus enteritidis sporogenes and *Coli*-group...	nil	—

Analyst's remarks :—

1.—The sample was clear, bright and free from odour on heating. It contains more organic matter than should be present in a really pure sample.

2.—This water is very hard and for this reason cannot be considered a first rate water for domestic use.

Alveston

Well in Carboniferous Limestone at the Ship Inn.

Analysis made and communicated by H. F. Barke, F.I.C., F.C.S., Public Analyst, Bristol.

	Grains per gallon
Saline ammonia	·0010
Albuminoid ammonia	·0022
Nitrogen as nitrate	·057
Nitrites	—
Chlorine as chloride	2·6
Dissolved solids	36
Earthy carbonates[1]	11·5
Earthy salts not carbonates[1]	3·5
Hardness[1]	15·0

To convert grains per gallon to parts per 100,000, ÷ by 0·7.

[1] Note : The "earthy carbonates" refer to calcium and magnesium carbonates. The "earthy salts not carbonates" are calcium and magnesium sulphates, nitrates and chlorides. The degrees of hardness are arrived at by adding these together + 1 for the soap required to lather distilled water.

Ashleworth

Well in Lower Lias, 40 ft. deep, at "Foscombe." See p. 49.
Analysis made by George Embrey, in 1890.[1]

	Grains per gallon
Sodium chloride	8·76
Sodium sulphate	13·26
Calcium carbonate	9·5
Calcium sulphate	133·3
Magnesium carbonate	34·45
Oxides of iron and aluminium	·7
Iodine and bromine	traces
Total solid matter	236·6
Sulphuretted hydrogen	·1

Analyst's remarks.—If the calcium sulphate be converted into a sodium salt, the amount would be 127·7 grains of the latter body.

Embrey has stated[2] "In the year 1890 I examined the water from a well at Ashleworth [that referred to above]. . . . We see that it had valuable salts in small amounts but the objectionable Gypsum is in excess. If such waters be suitably treated the Gypsum may be got rid of and Glauber's salt formed. The method is extremely simple.

"If a solution of common washing soda be added to water containing an excess of Gypsum, the carbonic acid previously united to the sodium will unite with the calcium forming chalk which will subside in about twelve hours, and the sulphuric acid previously combined with the calcium will pass to the sodium forming the soluble sodium sulphate, so that in this Ashleworth water the 133·5 parts of Gypsum will be replaced by 139·3 parts of sodium sulphate."

Ashton-under-Hill

Public Supply. Water derived from ? Sandy Beds of the Middle Lias (p. 49).

Analysis made and communicated by Cecil Duncan, F.I.C., F.C.S., County Analyst, Worcestershire.

	Parts per 100,000
No. [Analyst's]	5771
Vol. and p. [Analyst's book]	83A. 8293
Date	27/11/14
Description	tap
Solids in suspension	nil
,, solution	51
,, ,, appearance	white
,, ,, after ignition	49
Behaviour of solids on ignition	no change
Phosphates	nil
Chlorine calculated as NaCl	5·6
Free and saline ammonia	0·003
Albuminoid ammonia	0·001
Oxygen absorbed in 3 hours	nil
Nitrogen in nitrates	nil
Colour	clear
Deposit	nil
Smell	nil

[1] *Proc. Cotteswold Nat. F. C.*, vol. xx, pt. 1, 1918, p. 41 (see also pp. 34, 35).
[2] *Proc. Cotteswold Nat. F. C.*, vol. xx, pt. 1, 1918, pp. 34-35.

Hardness in degrees—	
Permanent	8·4
Temporary	20·7
Total	29·1
Poisonous metals	nil

Bibury

Spring "near Bibury" (? Bibury Springs) (p. 56). "Discharges 400 gallons per minute" (W. W. Fisher). Analysis made by W. W. Fisher.[1]

The Bibury Springs issue from the Great Oolite.

	Grains per gallon
Total solids	19·0
Chlorine in cholrides	·7
Nitrogen in nitrates	·147
Saline ammonia	·003
Albuminoid ammonia	·002
Oxygen absorbed, etc., in 3 hours... ...	·014

Bisley

1.—Well, 30 ft. deep, in Great Oolite.

Analysis made and communicated by Messrs. Philip Harris and Co. (1913) Ltd., Birmingham.

	Parts per 100,000
Total solids	47·6
Total hardness	22
Chlorides (as chlorine)	1·9
Nitrites	nil
Nitrates (as nitrogen)	·77
Saline ammonia	·001
Albuminoid ammonia	·007

2.—(*a*) Piedmont Valley Brook. See p. 57.

(*b*) Dillay Farm Brook (*i.e.*, the Slad Brook above the bridge below Snow's Farm.)

(*c*) Combined brook (Slad Brook) below in-flow of Piedmont Valley Brook.

Analysis by Rowland H. Ellis, F.I.C., F.C.S., City and County Laboratories, City Chambers, Clarence Street, Gloucester. 30th August, 1927.

	Parts per 100,000		
	(*a*)	(*b*)	(*c*)
Total dissolved solids	24·0	26·6	22·8
Combined chlorine	1·0	1·3	1·2
Nitrogen present as nitrates	·056	·032	·048
Nitrogen present as nitrites	none	none	none
Mineral ammonia	·0040	·0064	·0060
Organic ammonia	·0020	·0028	·0056
Oxygen required to oxidise the organic matter in 3 hours ...	·025	·012	none
Hardness in degrees—			
Temporary	15·7	16·2	16·2
Permanent	2·1	3·3	1·4
Total	17·8	19·5	17·6
Bacteriological Examination :—			
Micro-organisms in one cubic centimetre capable of growing on Gelatine at 22°C.	630	1120	1820
Micro-organisms in one cubic centimetre capable of growing on Agar at 37°C.	75	73	42
B. Coli present in	1c.c.	1c.c.	1 c.c.

[1] *The Analyst*, 1904, vol. xxix, no. 335, p. 30.

Microscopical Examination :—

(*a*) Shows the presence of a moderate sediment composed of mineral matter and vegetable matter.

(*b*) Shows the presence of a moderate sediment composed almost entirely of sand and crystalline mineral substances.

(*c*) Shows the presence of a moderate amount of sediment composed almost entirely of sand and crystalline mineral substances together with a little vegetable matter.

Remarks :—

(*a*) The analysis shows that this sample is not quite as good as Samples *b* and *c*.

It is, however, very similar in nature, and contains appreciable quantities of surface water, and this would have to be eliminated in order to provide a satisfactory water for a public supply, otherwise the water would have to be filtered.

(*b*) The analysis shows this sample to be a water of moderate quality.

It contains appreciable quantities of surface water, and this would have to be eliminated in order to produce a satisfactory water for a public supply. Otherwise filtration would be necessary.

(*c*) The analysis shows this sample to be water of moderate quality.

It contains appreciable quantities of surface water, and this would have to be eliminated in order to produce a satisfactory water for a public supply. Otherwise filtration would be necessary.

Bitton

From boring at the Golden Valley Paper Mills in Lower Lias, Rhaetic Keuper Marl and Pennant Grit. See p. 58.

Analysis made by J. W. Gatehouse, some time City Analyst, Bath, on 11th November, 1894.[1]

" Total Solids on Evaporation 53·12 Grains per Gallon, consisting of :—

Water of hydration	6·90
Chlorine 11·9 calculated as sodium chloride	19·50
Nitric acid ·7 calculated as sodium nitrate	·96
Sulphate of lime	12·70
Carbonate of lime	9·02
Silica	·14
Magnesia	·92
Oxide of iron	·40
Alumina	2·00
	52·54
Loss and not estimated	·58
	53·12
Temporary hardness	9°
Permanent hardness	9·5°
Total hardness	18·5°

The water was obtained from the gypseous Keuper Marl and amounted to some 5,760 gallons per hour.

[1] Winwood, Rev. H. H., *Proc. Bath Nat. Hist. and Antiq. F. C.*, vol. viii, 1895, pp. 145, 146.

Bourton-on-the-Hill

Springs thrown out by the Upper Lias clay, and fed with water that has percolated through the Inferior Oolite and Cotteswold Sands, in Bourton Woods, which constitute the supply to Blockley, Worcs. See p. 60.

Made and communicated by Cecil Duncan.

	Parts per 100,000
No. (Analyst's)	6213
No. of vol. and page (Analyst's Book)	62A, 6132
Date	1/9/16
Description	Tap
Solids in suspension	Nil
,, solution	20
,, ,, appearance	White
,, ,, after ignition	17
Behaviour of solids on ignition	No change
Phosphates	Nil
Chlorine calculated as common salt	2·2
Free and saline ammonia	0·0008
Albuminoid ammonia	0·001
Oxygen absorbed in 3 hours	Nil
Nitrogen in nitrates	0·2
Colour	Clear
Deposit	Nil
Smell	Nil
Hardness in degrees—	
Permanent	2·9
Temporary	8·3
Total	11·2
Remarks	Good

Broadwell

Spring issuing from at or near the base of the Sandy Beds of the Middle Lias in Manor Close. See p. 63.

Made and communicated by Cecil Duncan.

	Parts per 100,000
No.	984
Vol. and p.	30A, 2999
Date	25/2/03
Description	Spring
Solids in suspension	nil
,, solution	28
,, ,, appearance	White
,, ,, after ignition	22
Behaviour of solids on ignition	Nil
Phosphates	Nil
Chlorine calculated as NaCl	1·8
Free and saline ammonia	0·004
Albuminoid ammonia	0·006
Oxygen absorbed in 3 hours	0·01
Nitrogen in nitrates	0·2
Colour	Clear
Deposit	Nil
Smell	Nil
Hardness in degrees—	
Permanent	4·5
Temporary	11·5
Total	16·0
Poisonous metals	Nil

Analyst's remarks.—Good.

Brockworth

From Parish Pump by the side of the Birdlip-Gloucester road (p. 63).

Made by G. Embrey, 27th May, 1922, and communicated by R. C. Riches, Sanitary Inspector, Gloucester Rural District Council.

	Parts per 100,000
Total solid matter	152
Combined chlorine	5·8
Nitrates (as nitrogen)	absent
Nitrites	absent
Mineral ammonia	·012
Organic ammonia	·004
Oxygen required for combustion of organic matter	·020
Hardness in degrees—	
Permanent	31·2
Temporary	24·1
Total	55·3
	Bacteriological
Micro-organisms per c.c.	54
Bacillus enteritidis sporogenes	absent
Coli-group	absent

Analyst's remarks.—The water to which the above analysis refers was turbid, due to suspended particles of vegetable matter with various forms of Protozoa, such as *Paramaecium aurelia*.

I failed to find organisms which are usually present in a sewage contaminated water, but it is quite certain that it was polluted with putrescent organic matter derived from the surface of the ground surrounding the well. The water was slightly brackish due to its containing 6·69 grains of common salt per gallon.

Considering both the amount and nature of the solid matter present, I am of opinion that such water is dangerous and quite unfit for a public supply.

It was excessively hard.

From well in Lower Lias at Dean Farm. Oct. 19th, 1921.

Analysis made by G. Embrey, and communicated by R. C. Riches.

	Parts per 100,000
Total solid matter	1205
Combined chlorine	360
Nitrates (nitrogen as)	absent
Nitrites	absent
Mineral ammonia	·096
Organic ammonia	·008
Oxygen required for combustion of organic matter	·156
Hardness in degrees—	
Permanent	45·5
Temporary	35·0
Total	80·5
Bacteriological :—	
Micro-organisms per c.c.	185
Bacillus enteritidis sporogenes...	absent
Coli-group	absent

The water to which the above analysis refers was slightly turbid but odourless on heating. I fail to find evidence of sewage pollution, but notwithstanding this it is quite unsuited for domestic use, although as a medical

water it may be of great value. It was distinctly brackish, due to its containing nearly one ounce of common salt per gallon.

The following gives its approximate composition :—

	Grains per gallon
Sodium sulphate (Glauber's salt)	308·4
Sodium chloride (common salt)	415·0
Calcium sulphate (Gypsum)	45·5
Calcium carbonate (chalk)	34·9

Bromsberrow

From boreholes in Bunter Sandstone 200 ft. deep (p. 64). Urban District Council 1, 2.—Communicated by W. O. Thorp, Waterworks Engineer, Malvern. 3, 4.—Made and communicated by Cecil Duncan.

	(1)	(2)	(3)	(4)
	Grains per gallon	Parts per 100,000		
No.			1945	1945
No. of vol. and p.			44A, 4293	44A, 4293
Date			4/5/05	12/4/05
Description			Borehole	
Solids in suspension ...	nil	nil	trace	
,, solution	17·5	25·0	28	27·6
,, ,, appearance	white	white	white	
,, ,, after ignition	14·0	20·0	23·0	
Behaviour of solids on ignition	browning	browning	no change	
Phosphates	nil	nil	nil	
Chlorine (calculated as NaCl)	2·4	3·5	4·2	3·9
Free and saline ammonia ...	0·0004	0·0006	0·0016	nil
Albuminoid ammonia ...	0·004	0·006	0·0024	0·003
Oxygen absorbed in 3 hours	0·014	0·020	0·006	nil
Nitrogen as nitrates	nil	nil	0·8	0·9
Colour	clear	clear	opalescent	
Deposit	nil	nil	st. brown	
Smell	nil	nil	nil	
Hardness in degrees—				
Permanent	2·5		3·3	3·5
Temporary	8·9		8·1	6·5
Total	11·4		11·4	10
Remarks	good	good	good	good

		(3)	(4)
Cl	=	2·5	2·37
SiO_2	=	0·9	0·85
Fe_2O_3 and Al_2O_3	=	0·16	0·14
CaO	=	7·86	7·81
MgO	=	1·19	1·07
Na_2O	=	2·46	2·52
SO_3	=	1·76	1·8
CO_2	=	4·92	4·92
Na_2O_5	=	3·28	3·47

Brookthorpe

Spring just below Seven Leas Lane (p. 65).

Analysis made 16th June, 1914, and communicated by Messrs. J. M. Collett and Co., Ltd., Gloucester.

	Parts per 100,000
Free (or mineral) ammonia	nil
Albuminoid (or organic) ammonia	·005
Oxygen consumed in combustion of organic matter ...	·026
	Grains per gallon
Silica, iron and alumina	·28
Lime (CaO)	16·50
Magnesia (MgO), Potash (K_2O), Soda (Na_2O)	3·25
Sulphuric acid (H_2SO_4)	15·35
Hydrochloric acid (HCl)	1·72
Carbonic acid (H_2CO_3)	14·30
Nitric acid (HNO_3)	—
The above bases and acids may be combined as follows: –	
Sodium chloride (NaCl) ..., Potassium chloride (KCl)	3·20
Calcium sulphate ($CaSO_4$)	8·07
Calcium carbonate ($CaCO_3$)	23·50
Magnesium carbonate ($MgCO_3$)	—
Potassium and sodium sulphate	2·50
Magnesium sulphate	9·75
Total	47·02

Buckland

1.—Buckland.—Supply to village derived from spring thrown out by the Upper Lias clay and fed with water that has percolated through the Inferior Oolite and Cotteswold Sands (p. 66).

2.—Laverton. Supply to hamlet from spring, in field called "Cow Hill," similar in origin to preceding. See p. 66.

Analyses made and communicated by Cecil Duncan.

	(1)	(2)
	Parts per 100,000	
No.	6933	6934
Vol. and p.	105A, 24	105A, 24
Date	17/1/20	17/1/20
Description	spring	spring
Solids in suspension	trace	trace
,, solution	47	27
,, ,, appearance	white	white
,, ,, after ignition	42	22
Behaviour of solids on ignition	no change	no change
Phosphates	nil	nil
Chlorine calculated as NaCl	2·2	2·6
Free and saline ammonia	0·0008	0·003
Albuminoid ammonia	0·006	0·008
Oxygen absorbed in 3 hours	0·03	0·05
Nitrogen in nitrates	nil	0·2
Colour	opal	clear
Deposit	st. white	st. white
Smell	nil	nil

Hardness in degrees—	(1)	(2)
Permanent	4	3·6
Temporary	17	9·4
Total	21	13·0
Poisonous metals	nil	nil

Analyst's remarks.—Good.

Cheltenham

1.—Well at 18, Ambrose Street.

Water from well in sand-bed. Date of receipt of sample.—23rd December, 1911. Made and communicated by Messrs. J. M. Collett and Co., Ltd., Gloucester.

	Parts per 100,000
Free (or mineral) ammonia	·024
Albuminoid (or organic) ammonia ...	·016
Oxygen consumed in combustion of organic matter	·114
	Grains per gallon
Silica, iron and alumina	·63
Lime (CaO)	20·02
Magnesia (MgO)	2·84
Potash (K_2O)	4·80
Soda (Na_2O)	7·80
Sulphuric acid (H_2SO_4)	18·70
Hydrochloric acid (HCl)	10·24
Carbonic acid (H_2CO_3)	9·70
Nitric acid (HNO_3)	13·00
Nitrites	trace
Total solids	84·00

The above bases and acids may be combined as follows :—

Sodium chloride	14·80
Potassium chloride	2·00
Calcium sulphate	11·53
Calcium carbonate	15·76
Magnesium carbonate	—
Potassium sulphate	6·73
Magnesium sulphate	8·55
Calcium nitrate	17·21
Total	76·58

2.—Well at The Cheltenham Original Brewery (High Street). See p 207.

From well 35 ft. deep in sand-bed. Date of receipt of sample.—8th December, 1919. Analysis made and communicated by Messrs. J. M. Collett and Co., Ltd., Gloucester.

	Parts per 100,000
Free (or mineral) ammonia...	absent
Albuminoid (or organic) ammonia ...	·001
Oxygen consumed in combustion of organic matter	·003

	Grains per gallon
Silica, iron and alumina	1·00
Lime (CaO)	14·50
Magnesia (MgO)	1·13
Potash (K_2O) / Soda (Na_2O)	2·77
Sulphuric Acid (H_2SO_4)	7·96
Hydrochloric Acid (HCl)	1·74
Carbonic acid (H_2CO_3)	13·50
Nitric acid (HNO_3)	1·00
Total solids	40

The above bases and acids may be combined as follows :—

Sodium chloride (NaCl) / Potassium chloride (KCl)	2·88
Calcium sulphate ($CaSO_4$)	4·32
Calcium carbonate ($CaCO_3$)	21·83
Calcium nitrate ($CaNO_3$)	1·33
Magnesium sulphate ($MgSO_4$)	3·40
Sodium sulphate (Na_2SO_4)	2·85
Total	36·61

3.—Partial analyses of waters from wells in Cheltenham.

1912. Garrett, Dr. J. H.—*Proc. Cotteswold Nat. F.C.*, vol. xvii, pt. 3, p. 319.

	Solid residue upon evaporation	Chlorine	Nitric acid
Wells in main sand-bed [Superficial deposits]			
Thirlestaine Road	40	1·7	2·5
Coltham Fields	60	2·2	2·9
Marle Hill Road	44	4·5	2·0
Kings Road	59	3·0	4·5
Princes Street	83	4·0	4·0
St. James Street	119	7·5	7·0
Queen Street	146	10·2	15·6
Elm Street	124	6·5	16·6
Granville Street	160	17·0	25·0
Wells in the clay (Lower Lias)			
Francis Street	88	4·5	1·0
Haydon	292	39·0	0·2
Wells in river-side gravel—			
Sandford Mead (Corporation Well)	52	1·8	3·1
At Montpellier Baths	78	4·9	10·3

4.—Public Supply (Cheltenham Corporation Waterworks).

Analyses by C. C. Duncan, F.I.C., F.C.S.

Tap water at Cheltenham : (1) 22nd July, 1929 ; (2) 2nd August, 1929.

	1		2	
	Grains per gallon.	Parts per 100,000	Grains per gallon.	Parts per 100,000
Solids in suspension ...	none		slight trace	
Solids in solution, dried at 100°C	17·5	25·0	39·9	57·0
,, ,, appearance	white		white	
,, ,, after ignition	14·7	21·0	35·0	50·0
Behaviour of solids on ignition	no visible	change	slight browning	
Phosphates	none		none	
Chlorine calculated as common salt	1·6	2·3	13·5	19·2
Free and saline ammonia ...	0·0005	0·0008	0·0004	0·0006
Albuminoid ammonia ...	0·001	0·002	0·004	0·006
Oxygen absorbed in 4 hours	0·009	0·013	0·04	0·06
Nitrogen in nitrates ...	trace		trace	
Colour	clear		clear	
Deposit	none		very slight brown	
Smell	none		none	
Hardness in degrees—				
Permanent	4·1		6·8	
Temporary	7·3		9·2	
Total	11·4		16·0	
Poisonous metals	none detected		none detected	

Remarks.—(1) The water is certainly not from the River Severn. It is probably from springs above the town on the Cotteswold Hills. The water is of good quality and fit for drinking purposes. (2) The water is probably derived from the River Severn. It is quite satisfactory.

Childs Wickham

"From well 40 ft. deep [in Lower Lias with or without a capping of sand]."
Made and communicated by Cecil Duncan.

	Parts per 100,000
No.	4730
Vol. and p.	83A. 8241
Date	10/6/12
Description	Well
Solids in suspension	trace
,, solution	86
,, ,, appearance	white
,, ,, after ignition	72
Behaviour of solids on ignition	blacken
Phosphates	nil
Chlorine calculated as NaCl	11·6
Free and saline ammonia	0·002
Albuminoid ammonia	0·01
Oxygen absorbed in 3 hours	0·1
Nitrogen in nitrates	0·9
Colour	clear
Deposit	st. white
Smell	nil

Hardness in degrees—

Permanent	8·2
Temporary	23·8
Total	32·0
Poisonous metals	nil

Analyst's remarks.—Contaminated.

From boring in Lower Lias at Murcot.

Analysis made by Cecil Duncan.

	Grains per gallon	Parts per 100,000
No.	7354	
Vol. and p.	117A, 48	
Date	2/7/21	
Description	Borehole	
Solids in suspension	113·6	162·4
,, solution	592·9	847·0
,, ,, appearance	white	
,, ,, after ignition	513·1	733·0
Behaviour of solids on ignition	melting	
Phosphates	none	
Chlorine calculated as NaCl	114·4	163·5
Free and saline ammonia	0·2	0·4
Albuminoid ammonia	0·01	0·02
Oxygen absorbed in 3 hours	0·3	0·4
Nitrogen in nitrates	none	
Colour	opalescent	
Deposit	grey	
Smell	none	

Hardness in degrees—

Permanent	22·0
Temporary	7·0
Total	29·0
Poisonous metals	none detected

Analyst's remarks.—The above is a mineral water.

Cirencester

Well believed to be sunk through soil and clay into Churn-side gravel (Oolite) at M. & S.W.R. Station on the west side of railway line about 80 ft. north of Cricklade Road (p. 188).

Sixth Rep. Rivers Poll. Comm. (Water Supply), 1874, p 81.

	Parts per 100,000
Total solid impurity	59·20
Organic carbon	·144
Organic nitrogen	·019
Ammonia	0
Nitrogen as nitrates or nitrites	·626
Total combined nitrogen	·645
Previous sewage contamination	5940
Chlorine	2·80

Hardness in degrees—

Temporary	32·4
Permanent	5·5
Total	37·9

Remarks.—Clear and palatable.

Public supply. From Great Oolite (p. 181). Made by the Clinical Research Association, Ltd., London. Sample received 8th March, 1923; report dated 14th March, 1923. Communicated by Wentworth Jones, Surveyor, Cirencester Urban District Council.

Results.

(i) Chemical.	Parts per 100,000	Grains per gallon
Total solids (dried at 120°C.)	30·30	21·21
Combined chlorine	1·10	0·77
equivalent to NaCl	1·81	1·27
Nitric nitrogen	0·25	0·17
Nitrous nitrogen	nil	nil
Albuminoid nitrogen	0·0019	0·0013
Oxygen absorbed in 4 hours at 27°C.	0·013	0·009
Lead or copper	nil	nil
Hardness in degrees—		
Temporary (equivalent to $CaCO_3$)	21·6	15·1
Permanent	4·7	3·3
Total	26·3	18·4

(ii) Bacteriological (cultural and microscopical).

Average number of organisms producing visible colonies on gelatine plates, incubated at 20-22°C. for 2 days	108 per c.c.
Average number of organisms producing visible colonies on agar plates, incubated at 37·5°C. for 3 days	12 ,,
B. Coli	Not found in 100 c.c.
Streptococci	,, 30 c.c.
B. enteriditis sporogenes	,, 100 c.c.

Remarks.—The results show this water to be of excellent quality.

Coaley

Water supply, Sept. 8, 1873. [Presumably Spring Tyning, which issues from the base of the Cotteswold Sands, from which it is thrown out by the Upper Lias clay.]

Rivers Pollution Commission (1868), Sixth Report.—The Domestic Water Supply of Great Britain, 1874, p. 117.

	Parts per 100,000
Temperature (centigrade)	13·5
Total solid impurity	31·42
Organic carbon	·024
Organic nitrogen	·006
Ammonia	0
Nitrogen as nitrates and nitrites	·061
Total combined nitrogen	·067
Previous sewage or animal contamination	290
Chlorine	2·00
Hardness in degrees—	
Temporary	22·6
Permanent	5·3
Total	27·9

Remarks.—Clear and palatable.

Coberley

Salterley Grange Sanatorium for Consumption (p. 74). Analytical results of samples of water received from 1908-1913.—Made and communicated by J. F. Liverseege, F.I.C., Ph.C., some time City Analyst, Birmingham.

1. 15th February, 1909. Lower Well.
2. 20th ,, 1908. Well at Lodge.
4. 15th ,, 1909. Upper Well.
4. 12th ,, 1910. Well.
7. 31st May 1911.
7. 16th January 1913.

Number	Parts per 100,000								Appearance in 2 ft. tube
	Total Solid Matter	Free Ammonia	Albuminoid or Organic Ammonia	Nitrogen in Nitrates	Nitrogen in Nitrites	Oxygen consumed in 3 hours at 27°C (80°F.)	Chlorine in Chlorides	Alkalinity (as $CaCO_3$)	Turbidity[1]
1	35	·001	·002	0·2	—	·03	2·2	26·8	½
2	43	·000	·005	0·2	—	·04	3·0	27·6	¼
4	24	·001	·007	0·2	—	·06	1·5	11·0	1½
4	25·2	·001	·003	·35	—	·06	1·3	14·0	1½
7	23·6	·001	·001	·4	—	·01	1·2	13·3	2½
7[2]	24·0	·000	·003	0·1	0	·03	1·1	13·6	3½[3]

[1]" O " indicates clear.

[2]The sample did not become clear on standing and the turbidity was probably due to finely divided clay.

[3]Appearance observed in 1 ft. tube.

Permanent hardness	7·1
Temporary hardness	9·2
Total hardness	16·3

Seven Springs.—Water that has percolated through the Inferior Oolite and such Cotteswold Sands as are present. See p. 74.

Analysis published in *Sixth Rep. Rivers Poll. Comm.* (Water Supply), 1874.

	Parts per 100,000
Temperature (centigrade)	10·2°
Total solid impurity	22·60
Organic carbon	·012
,, nitrogen	·009
Ammonia	·001
Nitrogen as nitrates or nitrites ...	·510
Total combined nitrogen	·520
Previous sewage contamination... ...	4790
Chlorine	1·10
Hardness in degrees—	
Temporary	11·3
Permanent	5·6
Total	16·9

Analyst's remarks.—Clear and palatable.

Donnington

"Donnington Mill, a source of the Windrush." Water of the River Dikler that has travelled underground through the Cotteswold Sands and Inferior Oolite for some miles and is thrown out by the Upper Lias clay at Waterhead, close to Donnington Mill.

Published in *Sixth Rep. Rivers Poll. Comm.* (Water Supply), 1874.

	Parts per 100,000
Temperature (centigrade)	10°
Total solid impurity	27·48
Organic carbon	·039
,, nitrogen	·017
Ammonia	0
Nitrogen as nitrates or nitrites	·347
Total combined nitrogen	·364
Previous sewage contamination... ...	3150
Chlorine	1·40
Hardness in degrees—	
Permanent	6·6
Temporary	17·3
Total	23·9

Analyst's remarks.—Slightly turbid.

Down Hatherley[1]

1.—Borehole, 60 ft. deep [in Lower Lias], in meadow near Cheltenham Road, July, 1902.

	Grains per gallon
Solids in solution	132
,, suspension	268
Sodium chloride	15·2

Embrey states that this was "a dirty muddy water containing much clay suspended in the water, which did not clear for several days, so that only a partial analysis was made" (p. 34).

2.—Borehole, Woods Farm [in Lower Lias]. See p. 82.

	Grains per gallon
Total solids	764
Sodium chloride	195
,, sulphate	96
,, carbonate	42

Embrey states that this was a "clear water but . . . it contained more than an ounce and a half of mineral matter, and nearly half an ounce of salt per gallon, but as much sulphate of soda as is found in the best saline waters and also a very notable quantity of sodium carbonate."

3.—Village Well [in Lower Lias]. See p. 82.

	Grains per gallon
Total solids	166
Sodium chloride	52·1
,, sulphate	20·2

Dursley

Water from well to the Marlstone at the Waterworks of the Dursley Rural District Council (p. 84).

Date of receipt of sample by analyst.—16th Oct., 1913. Analysis made by G. Embrey.[2]

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[1] Analyses published by Embrey, George.—*Proc. Cotteswold Nat. F. C.*, vol. xx, 1918, p. 41 and 33, 34.

[2] *Ann. Rep. M.O.H.* for the Rural District of Dursley for the year 1913, p. 5.

	Parts per 100,000
Total solid matter	34
Combined chloride	1·6=NaCl.2·6
Nitrates (nitrogen as)	absent
Nitrites	absent
Mineral ammonia	absent
Organic ammonia...	·001
Oxygen required for combustion of organic matter	·003
Hardness in degrees	
Permanent	2·8
Temporary	19·6
Total	22·4
	Bacterilogical
Micro-organisms, per cubic centimetre...	6 harmless kinds
Bacillus enteriditis sporogenes	absent
Bacillus coli communis	absent

The sample was clear, bright and odourless. I fail to find evidence of sewage, or other pollution, and am of opinion that the water is unusually pure.

A bacteriological examination confirms the results obtained by chemical analysis.

The analysis of a sample taken from a tap in a private house gave exactly the same results, except that total solid matter amounted to 36 parts per 100,000, and there were present 12 harmless kinds of micro-organisms per cubic centimetre.

Dymock

Wells in :—(1) Old Red Sandstone, main street ; (2) 45 ft. deep, in Lower Keuper Sandstone at Great Lintridge.

Analyses made and communicated by Cecil Duncan.

	(1)	(2)
	Parts per 100,000	
No.	4744	3706
Vol. and p.	83A, 8248	54A, 5370
Date	22/6/12	13/7/09
Description	well	well
Solids in suspension	nil	trace
,, solution	137	37
,, ,, appearance	white	white
,, ,, after ignition	96	23
Behaviour of solids on ignition	oxid. N	no change
Phosphates	trace	nil
Chlorine calculated as NaCl	13·3	3·2
Free and saline ammonia	0·001	·0008
Albuminoid ammonia	0·01	0·0006
Oxygen absorbed in 3 hours	0·1	0·02
Nitrogen in nitrates	4·9	nil
Colour	clear	clear
Deposit	nil	st. brown
Smell	nil	nil
Hardness in degrees—		
Permanent	26·4	8·2
Temporary	16·6	12·7
Total	43·0	20·9
Poisonous metals	nil	nil

Analyst's remarks.—(1) Contaminated ; (2) good.

East Dean

Cinderford Waterworks

Water from Old Red Sandstone and Carboniferous Limestone (mixed). Analysis made by G. Embrey, and communicated by Wm. Whitehouse, Waterworks Engineer. See p. 86.

	Parts per 100,000
Total solid matter	36
Combined chlorine	1·6
Nitrites and nitrates	absent
Mineral ammonia	absent
Organic ammonia	·004
Oxygen required for combustion of organic matter	·013
Hardness in degrees—	
Permanent	10·4
Temporary	6·12
Total	16·52

Analyst's remarks.—The water to which the above analysis refers is very pure and gives no evidence of sewage or other pollution, it is well fitted for domestic use.

Ebrington

Analysis of spring water issuing from the Middle Lias, Ebrington. Shipston-on-Stour supply. See p. 90. Made and communicated by Cecil Duncan.

	Parts per 100,000
No.	6214
No. of vol. and p.	62A, 6133
Date	1/9/16
Description	Tap
Solids in suspension	Nil
,, solution	50
,, ,, appearance	white
,, ,, after ignition	43
Behaviour of solids on ignition	No change
Phosphates	Nil
Chlorine (calculated as NaCl)	2·2
Free and saline ammonia	0·001
Albuminoid ammonia	0·001
Oxygen absorbed in 3 hours	nil
Nitrogen as nitrates	nil
Colour	Clear
Deposit	nil
Smell	nil
Hardness in degrees—	
Permanent	7·2
Temporary	20·8
Total	28·0

Edgeworth

Hen Wood Petrifying Spring. Water thrown out by Fullers' Earth. Analysis by Cecil Duncan, F.I.C., F.C.S., 11th June, 1924.

	Parts per 100,000
Oxygen absorbed	nil
Solids in solution	27
,, ,, appearance	white
,, ,, after ignition	24
Phosphates	nil
Chlorine calculated as common salt ...	2·2
Hardness in degrees—	
Permanent	2·3
Temporary	10·0
Total	12·3
Lime, calculated as CaO	10·8

Eyford

Analysis of water from the 'Eyford Spring'—either the source of 'the Eye' or 'Roaring Wells'—which has percolated through the Oolites and Cotteswold Sands.

Published in *Rep. Rivers Pollution Comm.* (*Water Supply*), 1874.

	Parts per 100,000
Temperature (centigrade)	10°
Total social impurity	26·86
Organic carbon	·028
,, nitrogen	·004
Ammonia	·001
Nitrogen as nitrates or nitrites	·290
Total combined nitrogen	·295
Previous sewage contamination	2590
Chlorine	1·25
Hardness in degrees—	
Permanent	5·6
Temporary	18·3
Total	23·9

Analyst's remarks.—Clear and palatable.

Falfield

1, 2. Wells in Rhaetic, Eastwood Estate.
3, 4, 5. Wells in Silurian, Eastwood Estate.
Analyses made and communicated by H. F. Barke, Bristol.

	Grains per gallon				
	(1)	(2)	(3)	(4)	(5)
Saline ammonia	·0154	·0008	·0008	·0042	·0003
Albuminoid ammonia ...	·0148	·0100	·0109	·0082	·0199
Nitrogen as nitrate	·345	·184	·44	·23	·80
Nitrites	—	—	—	—	present
Chlorine as chloride	6·1	6·3	1·7	2·1	9·1
Dissolved solids	150	151	38	66	84
Earthy carbonates[1] ...		18	19·5	23·0	23
Earthy salts not carbonates[1]		76	1·5	17·0	16·5
Hardness[1]		95	22·0	41·0	40·5

[1] See Note, p. 244.

Gloucester

Public Supply (Gloucester Corporation Waterworks).

Analyses by Rowland H. Ellis, F.I.C., F.C.S.

1. Newent Pumping Station.

2. Tap in meadows near Westgate Bridge, Gloucester. (Newent and Ketford waters mixed.)

3. Ketford Pumping Station—No. 1 Borehole.

4. Ketford Pumping Station—No. 2 Borehole.

Note: The analyses of these waters have been selected from a large number to show the chief mineral constituents.

	1.	2.	3.	4.
Date	8.5.'29	5.5.'25	8.5.'29	25.10.'27
CHEMICAL EXAMINATION.		Parts per	100,000	
Total dissolved solids ...	48·5	58·96	39·8	137·5
Combined chlorine	1·7	7·80	4·7	37·2
Nitrogen present as nitrates	0·112	0·20	0·080	trace
Nitrogen present as nitrites	none	none	none	none
Mineral ammonia	0·0012	0·0036	0·0004	none
Organic ammonia	0·0012	0·0020	none	0·0032
Oxygen required to oxidise the organic matter in 3 hrs.	none	none	none	none
Hardness in degrees—				
Temporary	27·5	28·2	23·0	20·5
Permanent	7·5	5·2	1·5	16·0
Total	35·0	33·4	24·5	36·5
BACTERIOLOGICAL EXAMINATION.				
Micro-organisms in 1 c.c. capable of growing on gelatine at 22°C.	0	189	43	162
Micro organisms in 1 c.c. capable of growing on agar at 37°C.	6	7	1	4
B. coli	Absent in 50 c.c.	Absent in 10 c.c. present in 50 c.c.	Absent in 50 c.c.	Absent in 50 c.c.

Hempsted

"At a depth of only 20 feet [in the Lower Lias] a spring was discovered containing 3,260 grains of common salt per gallon, nearly 7½ ounces."[1]

Henbury

Wells in :—

1. Alluvium at Cowley Farm, King's Weston.
2. Ditto.
3. Alluvium at Compton Greenfield.
4. Lower Lias, Carpenter's Arms, Charlton.
5. Keuper Marl, Hillend Grove, Hembury.

[1] Embrey, G., *Proc. Cotteswold Nat. F. C.*, vol. xx, 1918, pt. 1, pp. 32 and 40.

Analyses made and communicated by H. F. Barke, Bristol.

	Grains per gallon				
	(1)	(2)	(3)	(4)	(5)
Saline ammonia	·0023	·7	·0011	·0462	·0003
Albuminoid ammonia ...	·0157	·0393	·0081	·0161	·0039
Nitrogen as nitrate	1·72	·05	·719	·2	·149
Nitrites	—	—	present	trace	—
Chlorine as chloride	9·5	91·3	4·0	6·7	3·6
Dissolved solids	73·0	225·0	64·0	105·0	63·0
Earthy carbonates[1] ...	33·5	66·0	—	—	22
Earthy salts not carbonates[1]	0	0	—	—	21·5
Hardness[1]	34·5	67·0	—	—	44·5

Kemble

Thames Head Well in Great Oolite. At abandoned Pumping Station of the Thames and Severn Canal (see p. 106).

Published in *Rep. Rivers Pollution Comm.* (*Water Supply*), 1874.

	Parts per 100,000
Temperature (centigrade)	10·5°
Total social impurity	27·44
Organic carbon	·037
Organic nitrogen	·018
Ammonia	0
Nitrogen as nitrates or nitrite	·316
Total combined nitrogen	·334
Previous sewage contamination	2840
Chlorine	1·35
Hardness in degrees—	
Temporary	18·0
Permanent	5·0
Total	23·0

Remarks.—Clear and palatable.

Kingswood (near Bristol)

Wells in Coal Measures at :—

1. Thingwell Farm, Fishponds.
2. Causeway, Fishponds.
3. Parnall Road, Fishponds.

Analyses made and communicated by H. F. Barke, Bristol.

	(1)	(2)	(3)
Saline ammonia	·0007	·0015	·0015
Albuminoid ammonia	·0066	·0049	·0026
Nitrogen as nitrate	·80	·589	·028
Nitrites	—	—	trace
Chlorine as chloride	6·2	12·0	3·3
Dissolved solids	75	81	36
	Grains per gallon		
Earthy carbonates[1]	19·5	20·5	—
Earthy salts not carbonates[1] ...	26·0	15·0	—
Hardness[1]	46·5	36·5	12·5

[1] See Note, p. 244.

Longborough

1. Ashwell Spring (p. 112).
2. Tights Spring. Water that has percolated through the Inferior Oolite and Cotteswold Sands.

Analyses made and communicated by Cecil Duncan.

	Parts per 100,000 (1)	(2)
No.	979	950
Vol. and p.	30A, 2994	30A, 2948
Date	25/2/03	15/1/03
Description	spring	spring
Solids in suspension	nil	trace
,, solution	29	55
,, ,, appearance	white	white
,, ,, after ignition	21	48
Behaviour of solids on ignition	nil	st. brown
Phosphates	nil	nil
Chlorine calculated as NaCl	2·2	7·0
Free and saline ammonia	0·0008	0·001
Albuminoid ammonia	0·001	·007
Oxygen absorbed in 3 hrs.	0·006	0·02
Nitrogen in nitrates	0·5	0·9
Colour	clear	clear
Deposit	nil	st. white
Smell	nil	nil
Hardness in degrees—		
Permanent	6·8	7
Temporary	6·8	14
Total	13·6	21
Poisonous metals	nil	nil

Analyst's remarks.—"[water from Ashwell Spring] good."

Marshfield

Bath Corporation Waterworks

1. Sample of water that has percolated through the basal Great Oolite beds and been thrown out by the Fullers' Earth (p. 115).

Communicated by Jules Dent Young, A.M.I.C.E., late Waterworks Engineer, Bath.

	Grains per gallon
Saline ammonia	·0003
Albuminoid ammonia	·0018
Nitrogen as nitrates	·12
Nitrites	absent
Oxygen absorbed in 4 hrs. at 80°F.	·003
Total dissolved solids	20·0
Earthy carbonates	9·5
Earthy salts other than carbonates	2·5
Hardness	13·0
Poisonous metals	absent
Sediment	a trace

2. Sample of water from the Upper Liassic Sands thrown out by the underlying Liassic clays (p. 115).

Communicated by Jules Dent Young.

	Grains per gallon
Saline ammonia	nil
Albuminoid ammonia	·0035
Nitrogen as nitrates	·17
Nitrites	nil
Oxygen absorbed in 4 hrs. at 80°F. ...	·007
Chlorine as chloride	·98
Total dissolved solids	29·4
Hardness in degrees—	
Temporary	13·1
Permanent	4·3
Total	17·4
Poisonous metals	Absent
Sediment	Very slight with vegetable debris

Matson

Red Well, Matson. Water from neighbourhood of Marlstone (Middle Lias). Analysis by G. Embrey.[1] See p. 116.

	Grains per gallon
Sodium chloride	3·7
Calcium sulphate	36·12
Sodium sulphate	3·65
Magnesium carbonate	16·31
Iron carbonate (ferrous)	3·05
Alumina	·46
Silica	1·4

Composition of mud on trough

	Per cent.
Silica (sand)	41·8
Iron oxide (ferric)	27·8
Organic matter	18·7
Calcium sulphate	11·7

Mr. Embrey remarks (*op. cit.*, p. 36) :—" The presence of iron salts is considered as conferring tonic properties, and one of this class, the so-called 'Holy Well,' at Matson, is worth consideration. The water is derived from the Middle Lias (marlstone series), and is evidently of great value ; it contains very little salt, a fair quantity of Magnesium carbonate, and a relatively large amount of Iron carbonate."

Mickleton

Sample of water from reservoir derived from spring issuing from the Sandy Beds of the Middle Lias. Public supply.

Made by Messrs. Philip, Harris and Co., Birmingham, in 1918, for R. G. Wootton, Manor House, Mickleton, and communicated by J. M. Dixon, of Mickleton.

	Parts per 100,000
Total solids	41·00
Chlorides (as chlorine)	2·2
Nitrites	nil
Nitrates (as nitrogen)	·15
Saline ammonia	·002
Albuminoid ammonia	·0035
Total hardness	19·9°

Analyst's remarks.—A first-class drinking-water.

[1] *Proc. Cotteswold Nat. F. C.*, vol. xx, pt. 1, 1918, p. 42.

Minchinhampton

Stroud Water Company.

1.—From well through lower portion of Cotteswold Sands and ? Upper Lias to Marlstone, being mainly water that has percolated through the Oolites and Sands, at the Pumping Station (standby).

Analysis made by G. Embrey on the 13th April, 1878.[1]

	Parts per 100,000
Total solid matter	20
Combined chlorine	2
Nitrates	absent
Mineral ammonia	·002
Organic	·002
Oxygen required for combustion of organic matter	·001
Hardness in degrees—	
Permanent	2·72
Temporary	2·56
Total	5·28

Micro-organisms, 15 per c.c., all harmless.

The water to which the above analysis refers is exceedingly pure, and gives no evidence of sewage or other pollution.

2.—Main Pumping Station, Clerk's Mill. Spring water from base of Cotteswold Sands: (*a*) from main sump; (*b*) from Bliss Mills pipe at main sump.

Reports by R. H. Ellis, City and County Laboratories, City Chambers, Gloucester. 9th January, 1928.

	Parts per 100,000 (*a*)	(*b*)
Total dissolved solids	31·4	30·9
Combined chlorine	1·1	1·1
Nitrogen present as nitrates	0·088	0·048
Nitrogen present as nitrites	None	None
Mineral ammonia	0·0012	0·0032
Organic ammonia	0·0024	0·0004
Oxygen required to oxidise the organic matter in 3 hrs.	none	none
Hardness in degrees—		
Temporary	21·5	20·0
Permanent	2·5	1·5
Total	24·0	21·5

Bacteriological examination :—	(*a*)	(*b*)
Micro-organisms in one cubic centimetre capable of growing on Gelatine at 22C.	9	17
Micro-organisms in one cubic centimetre capable of growing on Agar at 37C.	6	5
B. Coli present in 30 cubic centimetres ...	absent in 20 c.c.	
,, ,, 50 ,, ,, ...		absent in 40 c.c.

(*a*) Microscopic examination shows the presence of a very minute sediment.

[1] Published in Dr. F. St. George Mivart's "Report on the General Sanitary Circumstances . . . of the Stroud Rural and Nailsworth Urban Districts." *L.G.B. Report* (30th) 1900-1, p. 148.

Remarks.—The examinations of this water shows that it had been practically unaffected by the extremely unfavourable weather conditions at the time of collection. This is very satisfactory and although there is a slight increase in the number of *B. Coli* present, the general bacteriological condition is better The water is quite suitable for a public supply.

(*b*) Microscopic examination does not show the presence of any sediment.

Remarks.—The analysis shows that this water is suitable for a public supply. It shows a distinct improvement over the sample submitted on October 31st, especially in the bacteriological condition. When the extremely unfavourable weather conditions at the time of collection are taken into account, this is very satisfactory.

Newent

1.—Brierley Hill Farm. Well 40 ft. deep.

2.—Spring at Common Fields Farm.

Analysis made and communicated by Cecil Duncan.

	(1)	(2)
	Parts per 100,000	
No.	938	939
Vol. and p.	30A, 2930	2931
Date	18/12/02	18/12/02
Description	Well	Spring
Solids in suspension	trace	trace
,, solution	89	54
,, ,, appearance	white	white
,, ,, after ignition	64	42
Behaviour of solids on ignition	nil	nil
Phosphates	nil	nil
Chlorine calculated as NaCl	12·2	4·5
Free and saline ammonia	0·002	0·0006
Albuminoid ammonia	0·01	0·01
Oxygen absorbed in 3 hrs.	0·2	0·04
Nitrogen in nitrates	0·8	nil
Colour	opalescent	opalescent
Deposit	brown	brown
Smell	nil	nil
Hardness in degrees—		
Permanent	18	13·5
Temporary	19	13·5
Total	37	27
Poisonous metals	nil	nil

Newent Spa

See p. 123. Analysis made by Cecil Duncan. Sample received, Sept., 1922 and 1923. Composition varied with the rainfall.

	Grains per gallon	Parts per 100,000
Solids in suspension	trace	
,, solution, dried at 100°C.	401·8	574·0
,, ,, appearance	white	
,, ,, after ignition	379·4	542·0
Behaviour of solids on ignition	browning	
Phosphates	none	
Chlorine calculated as common salt	183·9	262·8

	Grains per gallon	Parts per 100,000
Free and saline ammonia	0·046	0·066
Albuminoid ammonia	0·003	0·005
Oxygen absorbed in 3 hours	0·07	0·1
Nitrogen in nitrates	none	
Colour	slightly opalescent	
Deposit	slight brown	
Smell	none	

Hardness in degrees—

Permanent	75
Temporary	20
Total	95

The total solids gave the following figures :—

	Parts per 100,000
Insoluble in HCl	0·8
Fe_2O_3 and Al_2O_3	0·5
$CaSO_4$	160·2
$MgSO_4$	44·7
Na_2SO_4	67·9
NaCl	259·6
KCl	3·3

Analyst's remarks.—The samples when received were slightly opalescent and had a slight brown deposit of hydrated oxide of iron.

Newland (Birchamp House)

From borehole in Old Red Sandstone, 77 ft. deep. See p.125.

Analyses made 29th October, 1920, by Bradley and Bliss and communicated by Guthrie Allsebrook and Co., Reading.

Colour, taste and odour	normal
Total solids	20 grains per gallon
Chlorine	1 grain ,,
Nitrites	—
Free ammonia	0·026 parts per million
Albuminoid ammonia	0·02 ,, ,,
Poisonous metals	—
Total hardness	20°

Analyst's remarks.—From the above data we consider this to be a good sample of water and quite suitable for drinking and domestic purposes.

Newnham

From well in Keuper Marl, "Northcot," just outside Newnham to the west of the railway and once known as "Clay Hill." See p. 195.

Sample collected by J. M. Collett, 7th March, 1912. Analysis made and communicated by Messrs. J. M. Collett and Co., Ltd., Gloucester.

	Parts per 100,000
Combined chlorine	4·7
Nitrites	absent
Nitrates	a trace
Mineral ammonia	·001
Organic ,, ...	·011
Oxygen consumed	·152

Analyst's remarks.—The water to which the above analysis refers is fairly pure and well suited for domestic use.

Pauntley

Water from well, No. 2 (See p. 132).

Analysis made by Cecil Duncan.

Sample received 26th July, 1922 and 1923. Composition varied with the rainfall.

	Grains per gallon	Parts per 100,000
Solids in suspension	trace	
,, solution, dried at 100°C.	595·0	850·0
,, ,, appearance	white	
,, ,, after ignition	566·3	809·0
Behaviour of solids on ignition	no visible change	
Phosphates	none	
Chlorine calculated as common salt	303·03	432·9
Free and saline ammonia	0·044	0·06
Albuminoid ammonia	0·005	0·008
Oxygen absorbed in 3 hrs.	0·05	0·07
Nitrogen in nitrates	none	
Colour	slightly opalescent	
Deposit	slight brown	
Smell	none	

Hardness in degrees—

Permanent	105
Temporary	30
Total	135

The total solids gave the following figures :—

	Parts per 100,000
Insoluble in HCl	0·8
Fe_2O_3 and Al_2O_3	0·3
$CaSO_4$	177·7
$MgSO_4$	55·8
Na_2SO_4	128·4
NaCl	431·8
KCl	1·4

Analyst's remarks.—The water had no odour, and on standing deposited slightly. The water contains much sulphate and a large quantity of common salt.

The total solids of the above sample, of another sample taken 17th March, 1923, and of samples taken from the springs numbered 4 and 6 ('Pauntley Spa,' disused) on the map, fig. 7, gave the following figures :—

	Parts per 100,000			
	(2)	(4)	(2)	(6)
Date	26.7.22	17.3.23	17.3.23	17.3.23
Insoluble in HCl ...	0·8	1·2	trace	trace
Fe_2O_3 and Al_2O_3 ...	0·3	trace	trace	trace
CaO	73·2	60·0	87·0	53·0
MgO	18·7	13·3	18·1	10·1
SO_3	214·0	108·3	216·7	116·6
Cl	262·5	216·7	269·4	173·7
Na_2O	285·0	182·0	243·9	171·8
H_2S	none	slight trace	0·1	slight odour of H_2S

Prestbury

Well on property belonging to C. Reeves, Marle Hill Court Road, formerly on part of the Marle Hill Court Estate. See p. 136.

Analysis made (August 2nd, 1904) by E. W. Lucas, F.I.C. (on behalf of Messrs. John Bell & Co., 225, Oxford St., London, W.) for A. W. Boulton, of Marle Hill Court, and communicated by R. W. Boulton.

	Grains per gallon
Total solid matter (dried at 212°F.) ...	995·00
Chlorine	157·50
Total hardness	22·0
Saline ammonia	0·1200
Albuminoid ammonia	0·0042
Nitrogen as nitrates	0·1728
Nitrites	a faint trace
Oxygen consumed in 3 hrs.	0·064
Poisonous metals	absent
Appearance in a 2 ft. tube	clear

This mineral matter appears to be free from what is generally termed pollution.

The total solids of the Mineral Water were as follows :—

	Grains per gallon
Potassium sulphate	44·72
Sodium chloride	295·10
,, nitrate	1·06
,, sulphate	398·56
,, bicarbonate	159·05
Calcium bicarbonate	44·16
Magnesium carbonate	40·11
Siliceous matter	a trace
	982·76

It will be noticed that the total weight adds up to 27·76 grains per gallon more than the total solid residue. This is accounted for by the loss of carbon dioxide and water driven off at 212°F. From the amounts of sulphates and chlorides this may be considered a useful alkaline purgative water.

Pucklechurch

Well in Lower Lias at Church Farm.

Analysis made and communicated by H. F. Barke.

	Grains per gallon
Saline ammonia	·0047
Albuminoid ammonia	·0144
Nitrogen as nitrates...	·2
Nitrites	trace
Chlorine as chloride	2·0
Dissolved solids	39

Sandhurst

From well and borehole in Lower Lias at Wallsworth Hall (p. 141).

Analyses G. Embrey, F.I.C.

	Sample from 40 ft.	Sample from 50 ft.	Sample from 60 ft.	Sample from 170 ft.
Parts per 100,000—				
Total solid matter	776	960	540	730
Combined chlorine	150	200	90	110
Nitrates (nitrogen as)	absent	absent	absent	absent
Nitrites	absent	absent	absent	absent
Mineral ammonia	·04	·076	·092	·032
Organic ,, ...	·021	·012	·019	·019
Oxygen required for combustion of organic matter	·083	·055	·138	·143
Hardness in degrees—				
Permanent	60·9	62·3	63·0	24·5
Temporary	39·2	39·2	37·8	38·5
Total	100·1	101·5	100·8	63·0
Common salt (grains per gallon) ...	173	230·7	103·8	127

Sezincote

From spring, tapped in 1915, situate to the west of Sezincote between that place and Hinchwick. Made and communicated by Cecil Duncan.

	Parts per 100,000
No.	6517
Vol. and p.	105A, 16
Date	22/5/18
Description	Spring
Solids in suspension	nil
,, solution	24
,, ,, appearance	white
,, ,, after ignition	19
Behaviour of solids on ignition	no change
Phosphates	nil
Chlorine calculated as NaCl	2·3
Free and saline ammonia	0·003
Albuminoid ammonia	0·002
Oxygen absorbed in 3 hrs.	0·02
Nitrogen in nitrates	nil
Colour	clear
Deposit	nil
Smell	nil
Hardness in degrees—	
Permanent	2·2
Temporary	10·0
Total	12·2
Poisonous metals	nil

Analyst's remarks.—Good.

Shipton Moyne

Sample labelled "Borehole No. 3 (overflow), Shipton Moyne, 4.8.1916." West Gloucestershire Water Co. See p. 150.

Made and communicated by Dr. J. C. Thresh, The Counties Public Health Laboratories, 91, Queen Victoria Street, London, E.C.

Physical Examination

Turbidity: slight. Trace of iron.

Colour: Faint yellow. Odour: none. Reaction: neutral.

Chemical Examination

Results expressed in parts per 100,000

Ca	Mg	Na	Fe	CO_3	SO_4	Cl	NO_3	Probable combinations	
7·2	·8	8·35	tr.	15·6	5·1	5·6	·18		
7·2				10·8				$CaCO_3$	18·0
	·8			1·95				$MgCO_3$	2·75
		2·2		2·85				Na_2CO_3	5·05
		2·45			5·1			$NaSO_4$	7·55
		3·64				5·6		NaCl	9·25
		·06					·18	$NaNO_3$	·25
									1·15
Total solid constituents dried at 180°C.									44·0

Hardness. Temporary 18°. Permanent 2·5°. Total 20·5°

Free ammonia	0·0200
Organic ammonia	0·0026
Oxygen absorbed in 3 hours at 37°C.	0·0300
Nitrites	nil

Note: To convert the above parts per 100,000 into grains per gallon multiply by 0·7.

Sample labelled "Borehole Shipton Moyne. 3.30 p.m. April 14th, 1914." West Gloucestershire Water Co.

Made and communicated by Dr. J. C. Thresh.

Results expressed in parts per 100,000

Ca	Mg	Na	Fe	CO_3	SO_4	Cl	NO_3	Probable combinations	
11·6	1·5	4·75	—	20·0	8·5	1·9	·9		
11·6				17·4				$CaCO_3$	29·0
	1·05			2·6				$MgCO_3$	3·65
	·45				1·75			$MgSO_4$	2·2
		3·2			6·75			Na_2SO_4	9·95
		1·2				1·9		NaCl	3·1
		·35					·9	$NaNO_3$	1·25
								SiO_2	1·25
Total solid constituents dried at 180°C.									50·4

Hardness. Temporary 20°. Permanent 12°.	Total 32°
Free ammonia	·024
Organic ammonia...	·0096
Oxygen absorbed in 3 hrs. at 37°C.	·084
Nitrites	nil

Note: To convert the above parts per 100,000 into grains per gallon multiply by 0·7.

Siddington

From well in gravel (Oolite) on Oxford Clay. See p. 152.

Analysis made by G. Embrey on 5th May, 1922, and communicated by E. G. Mathews, Sanitary Inspector, Cirencester Rural District Council.

	Parts per 100,000
Total solid matter	52
Combined chlorine	2·0
Nitrates (nitrogen as)	absent
Nitrites	absent
Mineral ammonia	·18
Organic	·014
Oxygen required for combustion of organic matter	·076
Hardness in degrees—	
Permanent	7·7
Temporary	15·4
Total	23·1
	Bacteriological
Micro-organisms per cubic centimetre ...	260
Bacillus Enteritidis Sporogenes	absent
Coli-Group	absent

The water to which the above analysis refers was clear but gave out an earthy odour on heating.

The 260 microbes consisted of the following :—

Mucors	40
B. Fluorescens liquifaciens	200
Torulas	20

I fail to find evidence of sewage pollution; the mineral ammonia yielded is greater than usually found in pure waters and has probably a fossilized origin; notwithstanding this I am of opinion that such water is well suited for drinking purposes and for general domestic use.

South Cerney

Boring 124 ft. at the Manor House (Capt. E. T. Cripps). Water from Kellaways Beds. Well still in use (p. 154).

Made by Prof. Ed. Kinch 6th June, 1888.

	Grains per gallon
Total solid residue	39·55
Chlorine equivalent to common salt ...	1·77
Oxygen consumed from potassium permanganate in 1 hr.	·023
Do. in 3 hrs.	·032
Nitrates	very small amount indeed
Ammonia	traces
Phosphates	traces

The water was slightly turbid from suspended mineral matter, it was free from smell and colour, but had a slight flat or mawkish taste—especially when warmed. It was distinctly alkaline to delicate test paper.

The residue left on evaporation was white and changed but little when heated, it was strongly alkaline and contained a good deal of sulphates, but was almost free from lime. The water was found to be free from hardness: it required the same amount of soap to produce a lather as distilled water. As much of the solid residue of the water as was available was further examined and found to consist mainly of sodium carbonate with some sodium sulphate and sodium chloride, and very small quantities of lime and magnesia salts, silica, etc. The alkalinity of the residue was equal to that which would be produced by 28·70 grains of dry carbonate of soda to the gallon of original water. Approximately the solids in the water consist of

	Grains per gallon
Carbonate of soda	28·7
Sulphate of soda	4·0
Sodium chlorine	1·8
Calcium carbonate	·5
Magnesium carbonate	·1

This is a peculiar water differing from the ordinary spring and well water of the district in being almost free from lime and magnesia salts but containing carbonate of soda. It is a dilute alkaline mineral water. It is admirably suited for washing purposes and for many domestic purposes, but it is perhaps hardly the best for drinking if continuously used, on account of the carbonate of soda it contains—3 to 4 grains per pint. It is free from all signs of contamination with sewage and similar matter.

H. B. Woodward comments on the fact that " out of 39 grains per gallon, no less than 29 were carbonate of soda."[1]

Stanway

Analysis, made and communicated by Cecil Duncan, of spring water in Lidcombe Wood that has percolated through Inferior Oolite and Cotteswold Sands. Evesham and Pebworth Joint Water Committee's source of supply (p. 157).

	Parts per 100,000
No.	6125
Vol. and page	94A, 9379
Date	15/3/16
Description	Tap
Solids in suspension	trace
,, solution	25
,, ,, appearance	white
,, ,, after ignition	22
Behaviour of solids on ignition	No change
Phosphates	Nil
Chlorine calculated as NaCl	1·9
Free and saline ammonia	0·002
Albuminoid ammonia	0·001
Oxygen absorbed in 3 hrs.	0·006
Nitrogen in nitrates	nil
Colour	clear
Deposit	nil
Smell	nil
Hardness in degrees—	
Permanent	3·5
Temporary	11·0
Total	14·5
Poisonous metals	nil

[1] 'Jurassic Rocks of Britain,' vol. v (*Mem. Geol. Surv.*), 1895, p. 333.

Analysis of sample of water taken from the source of the Windrush at Taddington. The water has percolated through the Inferior Oolite and Cotteswold Sands. Published in *Rep. Rivers Poll. Comm.* (*Water Supply*), 1874.

	Parts per 100,000
Temperature (centigrade)	11·8°
Total solid impurity	31·20
Organic carbon	·047
Organic nitrogen	·014
Ammonia	0
Nitrogen as nitrates or nitrite	0
Total combined nitrogen	·014
[1]Previous sewage contamination	0
Chlorine	1·10
Hardness in degrees—	
Temporary	25·7
Permanent	4·3
Total	30·0

Remarks.—Traces of iron.

Stow-on-the-Wold

Public supply, Urban District Council's Well, through Oolites ? to Upper Lias clay. See p. 196. Made by G. Embrey and communicated by Dr. Edwin Denning, M.O.H., on 23rd October, 1911.

	Parts per 100,000
Total solid matter	48
Combined chlorine	4
Nitrates (nitrogen)	·33
Nitrites	absent
Mineral ammonia	absent
Organic ,, ...	·006
Oxygen required for combustion of organic matter	·007
Hardness in degrees—	
Permanent	13·3
Temporary	9·8
Total	23·1

Bacteriological :—

Micro-organisms per cubic centimetre ...	50 harmless kinds
Bacillus enteritidis sporogenes	absent
Bacillus coli-communis	absent

The water to which the above analysis refers is very pure and gives no evidence of sewage or other pollution. It is well suited for a public supply. Dr. Denning states that later analyses are equally satisfactory.

Stroud

Urban District Council's supply. See p. 197.

1.—Stroud Hill Supply from springs thrown out by the Fullers' Earth.

2.—Gainey's Well, spring thrown out by Upper Lias clay.

Analyses by Rowland H. Ellis, F.I.C., F.C.S., 22nd July, 1927.

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[1] An old term, not now used, based on the idea that all nitrates and ammonia are derived from sewage. See also pp. 255, 256, 257, 261, 263.

	Parts per 100,000 (1)[1]	(2)
Total dissolved solids	32·1	37·9
Combined chlorine	1·4	3·3
Nitrogen present as nitrates	0·088	0·42
Nitrogen present as nitrites	none	none
Mineral ammonia	0·0312	0·0056
Organic ,, ...	0·0476	0·0048
Oxygen required to oxidise the organic matter in 3 hours	0·054	none
Hardness in degrees—		
Temporary	21·6	12·7
Permanent	none	6·9
Total	21·6	19·6
Free chlorine	none	none
Bacteriological examination :—		
Micro-organisms in 1 c.c. capable of growing on gelatine at 22°C.	456	38
Micro-organisms in 1 c.c. capable of growing on agar at 37°C.	45	53
B. Coli absent in 2 c.c. present in	5 c.c.	5 c.c.

Microscopical examination :—

1.—Shows the presence of a heavy sediment, composed almost entirely of lime salts.

2.—Shows the presence of only the slightest sediment.

Tetbury District

Analyses communicated by Dr. J. Middleton Martin.[2]

	Chavenage[1] (G. Embrey 6.vii.1914)	Tetbury[2] (Dr. P. Frankland 1892)	Tetbury[3] (G. Embrey 16.x.1913)	Kemble[4] (W. R. Bird 9.xi.1911)	Westonbirt[5] (G. Embrey 28.iii.1914.	Sherston (W. J. Read 22.iv.1914)
Total solids ...	45	36·84	36	30·7	35	52
Organic carbon ...	—	·095	·03	—	—	—
Oxygen absorbed ...	·021	—	—	—	·05	·02
Free ammonia ...	abs.	·010	·001	—	abs.	·003
Organic ammonia...	·003	—	·005	—	·012	·007
Organic nitrogen ...	—	·032	—	—	—	—
Nitrogen as nitrates	abs.	·247	·41	—	·5	trace
Nitrogen as nitrites ...	abs.		abs.	—	abs.	nil
Total combined nitrogen ...	—	·287	—	—	—	—
Chlorine	1·7	1·0	1·6	1·07	1·3	15·5
Alkalinity as chalk	—	—	—	21·0	—	—
Hardness—						
Temporary ...	15·6	24·8	16·6	12·2	14·5	9·5
Permanent ...	2·0	5·2	4·4	6·0	3·3	7·8
Total	17·6	30·0	21·0	18·2	17·8	17·3

1. Chavenage House Borehole. 2. Borehole at the Urban District Council's Water Works, Blind Lane. 3. Brewery Well (Hampton Street). 4. Kemble Junction Borehole. 5. Westonbirt House supply.

[1] Water chlorinated.

[2] Richardson, L., *Proc. Cotteswold Nat. F. C.*, vol. xviii, pt. 2, 1914, p. 245.

Toddington

"Well [probably in Lower Lias] at Toddington. Received 26th June 1911." Analysis made and communicated by Messrs. J. M. Collett & Co., Ltd., Gloucester.

	Parts per 100,000
Combined chlorine	26·8
Nitrites and nitrates	absent
Mineral ammonia	·026
Organic ammonia	·012
Oxygen consumed	·061
Hardness in degrees—	
Temporary	27·3
Permanent	49·7
Total	77

Upton St. Leonards

From well, about 26 ft. deep in Lower Lias clay, at "Highmeadow," Wheatridge. See p. 166.

Analysis made by George Embrey on 20th April, 1907, and communicated by Max Bellows, of "Highmeadow."

	Parts per 100,000
Total solid matter	256
Combined chlorine	2·2
Nitrites	absent
Nitrates	trace
Mineral ammonia	·001
Organic ,, ...	·01
Oxygen required for combustion of organic matter	·08
Hardness in degrees—	
Permanent	55·85
Temporary	64·65
Total	120·5

Analyst's remarks.—The water to which the above analysis refers contains so much mineral matter as to render it unfit for domestic use. It is fairly pure as regards organic matter and gives no evidence of sewage pollution. If no better source be available it would be advisable to run filtered rain water into the well so as to dilute its contents; in this way a fair product would be obtained. The mineral matter consists of the sulphates and carbonates of lime and magnesia.

Weston Subedge

Newcombe Spring, being of water that has percolated through the Inferior Oolite and Cotteswold Sand. Public Supply, see p. 170. Made and communicated by Cecil Duncan.

	Parts per 100,000
No.	5237
Vol. and p.	83A, 8270
Date	17/12/13
Description	tap
Solids in suspension	trace
,, solution	42
,, ,, appearance	white
,, ,, after ignition	37
Behaviour of solids on ignition	no change
Phosphates	nil
Chlorine calculated as NaCl	3·7

	Parts per 100,000
Free and saline ammonia	nil
Albuminoid ammonia	0·002
Oxygen absorbed in 3 hrs.	0·01
Nitrogen in nitrates	nil
Colour	clear
Deposit	nil
Smell	nil
Hardness in degrees—	
Permanent	3·6
Temporary	13·9
Total	17·5
Poisonous metals	nil

Analyst's remarks.—Good.

Whittington

Syreford Spring

Water from Inferior Oolite thrown out by Upper Lias clay (p. 171). Sixth Rep. River Pollution Comm. (Water Supply), 1874.

	Parts per 100,000
Temperature (centigrade)	10·0°
Total social impurity	22·34
Organic carbon	·029
Organic nitrogen	·008
Ammonia	0
Nitrogen as nitrates or nitrite	·222
Total combined nitrogen	·230
Previous sewage contamination	1900
Chlorine	1·20
Hardness in degrees—	
Temporary	13·8
Permanent	5·1
Total	18·9

Analyst's remarks.—Clear and palatable.

Woodmancote

1.—Stockwell Spring, Cleeve Hill. 13th January, 1909. See p. 175.
2.—'Dick's Spring,' Cleeve Hill. 22nd October, 1906. See p. 175.
Springs thrown out by Upper Lias clay. Analyses by G. Embrey.

	(1)	(2)
	Parts per 100,000	
Total solid matter	38	24
Combined chlorine	1·6	1·2
Nitrites and nitrates	nil	nil
Mineral ammonia	nil	·002
Organic ,, ...	·006	·006
Oxygen required for combustion of organic matter	·021	·06
Hardness in degrees—		
Permanent	6·2	
Temporary	7·7	
Total	13·9	

Analyst's remarks.—(1) This water is well suited for domestic use. It is identical with that supplied to the houses "Highbury," "Highgate," "Pendennis" and "Tregenna." (2) This water is well suited for domestic purposes.

VII.—BIBLIOGRAPHY

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Maps

A.—Sheets of the original series. On the scale of an inch to a mile

34.—Tetbury, Stroud, Cirencester, Fairford, Lechlade, etc. (1857. Revised, 1859). (*Horizontal Sections*, 59 and 72, Section 2).

35.—Bristol, Marshfield, Wotton-under-Edge, Dursley, Stonehouse, Lydney, Tidenham, Berkeley, Wickwar, Chipping Sodbury, etc. (1845, Revised, 1866, 1872). (*Horiz. Sect.*, 14, 15, 17, 106, 107, 111: *Vertical Sections*, 11, 12, 46, 49, 51).

43 N.E.—Newent, Dymock, Bromesberrow, Upleadon, Hasfield, etc. (1845. Revised, 1855.)

43 S.W.—Clearwell, Coleford, Symonds Yat, Lydbrook, etc. (1845). *Horiz. Sect.*, 12: *Vert. Sect.* 7).

43 S.E.—Cinderford, Mitcheldean, Blakeney, Newnham, Longhope, Westbury-on-Severn, Whitminster, Haresfield, Gloucester, Sandhurst, etc. (1845. Revised, 1855). (*Horiz. Sect.*, 12, 13, 15: *Vert. Sect.*, 7 12, 15).

44.—Painswick, Northleach, Bourton-on-the-Water, Stow-on-the-Wold, Moreton in Marsh, Chipping Campden, Winchcomb, Tewkesbury, Cheltenham, Barnwood (Gloucester). (1856) (*Horiz. Sect.*, 59, 72: *Vert. Sect.*, 47).

54 S.E.—Pebworth, Long Marston, Welford-on-Avon, Clifford Chambers (1854).

B.—Sheets of the new series. On the scale of an inch to a mile. None issued as the County has not been re-surveyed as yet for this purpose.

C.—Sheets of the Index Map. On the scale of 4 miles to an inch.

Original Series.—Out of print.

New Series.—14. A small portion of the County is included in the extreme south-western part.

15. The greater portion is represented on this map.

17 (part) 18. A small portion is represented on the extreme north-eastern part.

19. A small portion is represented on the extreme north-western portion.

Sheets of Horizontal Sections

(Scale: 6 inches=1 mile)

12.—Section from the Ebwy River near Cefn Crib, Monmouth, across the Forest of Dean, to Garden Cliff, Gloucestershire. Out of print.

13.—No. 1. Section from Edge Hill, Forest of Dean, to Taynton House. No. 3. Through Keys (or Chase) End Hill and Berrow Hill. No. 8. By Howler's Heath and the Obelisk in Eastnor Park.

14.—No. 1. Section from Pyrton Passage, through Cam Long Down and Uley Bury, to Kingscote Park. No. 2. Section from the Great Western Railway, near Saltford Station, to the Box Valley, near Slaughterford. No. 3. Section from Dodington Park, by Winterbourn, to the Severn Flats, near Almondsbury. (1845, Revised to 1867).

15.—No. 1. Continuation of Section 1, Sheet 22. Section from Ridge Barn Hill, near Castle Cary, Somerset, to Jay Hill, near Bitton, Gloucestershire. No. 2. Section through the Forest of Dean from South to North. (1845. Revised, 1871).

17.—Section from Glastonbury Tor, across the Mendips, by Dundry Hill, Clifton, Bristol, to the Severn Flats, near Compton Greenfield. (1844. Revised, 1871). Crosses *Horiz. Sect.*, 106.

59.—Section from Marlborough Downs to the River Avon, near Great Comberton, Worcestershire; crossing the Cotteswold Hills and the outlier of Bredon Cloud. (1860). With a brief explanation. Price 2d.

72.—No. 1. Continuation of Sheet 71. No. 2. Section from Lambourn Downs, Berkshire, to Parsonage Farm, near Kencott, Gloucestershire. (1867). With a brief explanation. Price 2d.

106.—Section from Nailsea, through Flax Bourton and Bedminster to Fishponds, Bristol. (1875). (Crosses *Horiz. Sect.* 17).

107.—Section from Portskewet in Monmouthshire across the Severn at New Passage, by Stoke Gifford in Gloucestershire, thence across the Bristol Coalfield to Wapley. (1875). (Crosses *Horiz. Sect.*, 14).

111.—Section across the Bristol Coalfield and the north part of the Somerset Coalfield, from Cromhall, through Iron Acton, to Keynsham and Compton Dando, in Somerset. (1875).

Sheets of Vertical Sections

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11.—Carboniferous Rocks in the vicinity of Bristol. (1873).

12.—Sections illustrative of the Passage of the Old Red Sandstone into the Carboniferous Limestone in South Wales and South-western England.

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